Forest Products Journal

NORTHWEST WOOD PRODUCTS CLINIC—p. 27

W. Jeter Eason will be Installed as 12th President of FPRS at Madison National Meeting, June 22–27

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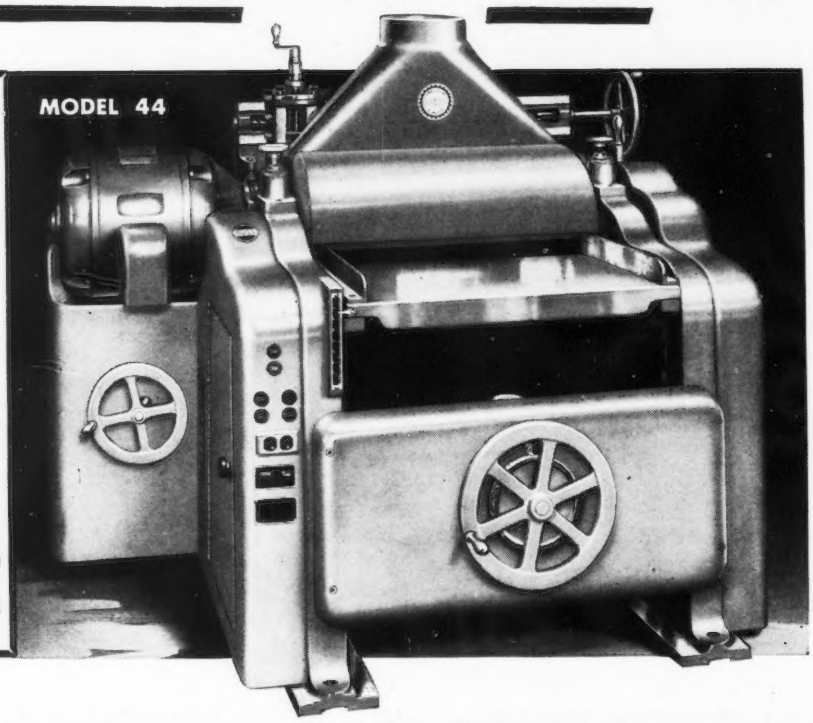

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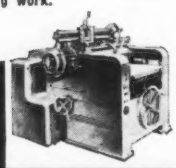

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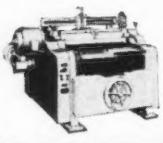

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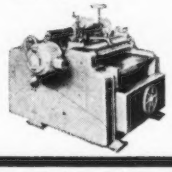

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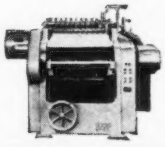

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FOREST PRODUCTS JOURNAL

Vol. VIII, No. 5 May, 1958

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Correspondence on editorial matters should be addressed to the Editor, at the Executive Office. The Society is not responsible for views expressed in publications.

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IMPORTANT FPRS DATES

June 22–27, 1958: Twelfth National Meeting, Madison, Wis.

Aug. 21–22, 1958: Great Lakes Section Meeting, Houghton, Mich.

Oct., 1958: Joint Pacific Northwest —Inland Empire Section Meeting, Vancouver, B. C.

Oct., 1958: Midwest Section Meeting

Nov. 6–7, 1958: Carolinas–Chesapeake Annual Section Meeting, Charlotte, N. C.

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Madison 5, Wisconsin

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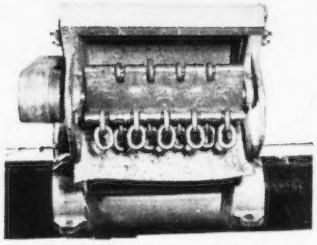

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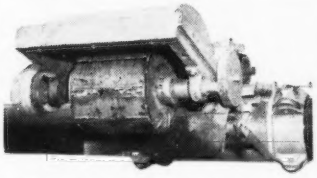

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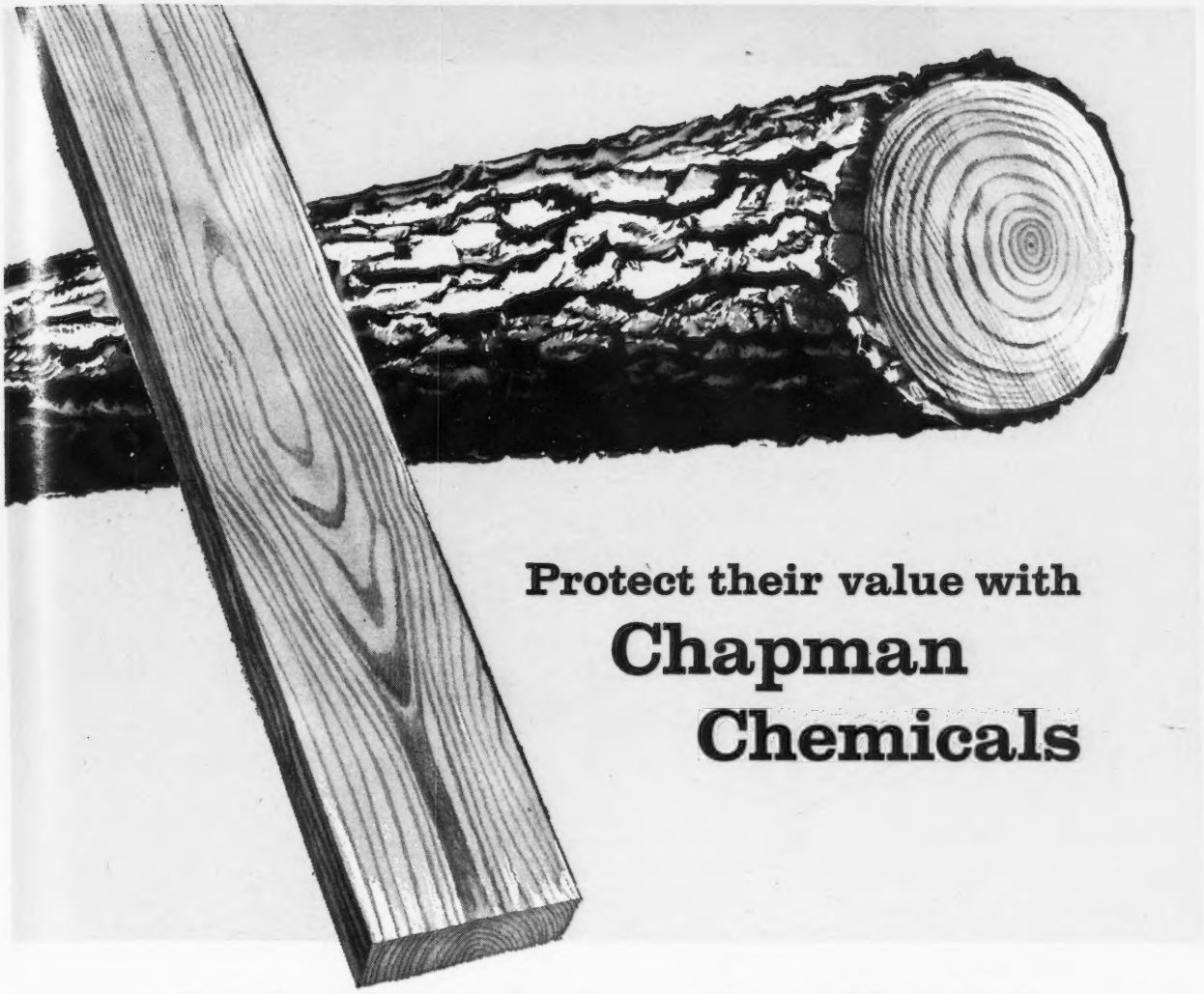

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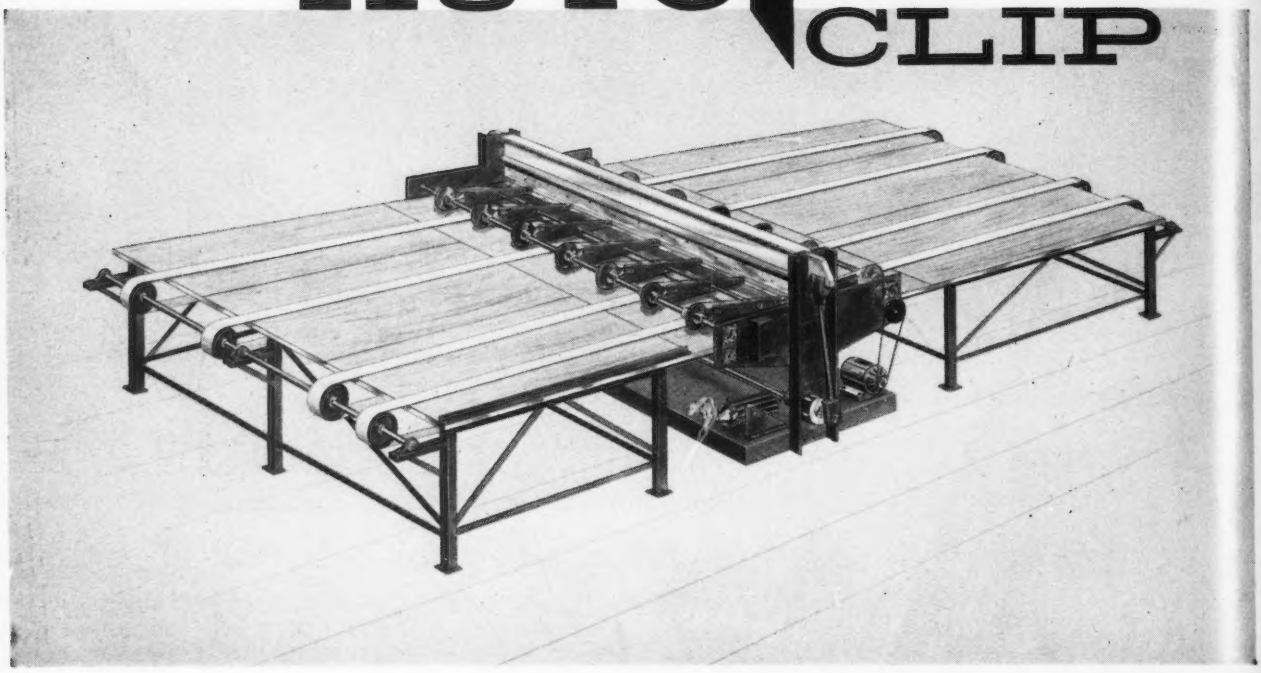

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FPRS NEWS-DIGEST

Volume VIII MAY, 1958 Number 5

Dynamic Program Ready for June Meeting

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H. D. TIEMANN

I. I. SIKORSKY

G. H. RODERICK

More than 80 papers on modern forest products technology will be featured at the 12th National Meeting of FPRS, June 22–27, at Madison, Wis. The technical program, the most comprehensive in the Society's history, is expected to attract over 700 persons from the United States, Canada, and overseas.

A major convention highlight will be the keynote session, which has as its theme, "Insurance for the Future—through Forest Products Research". Mr. V. L. Harper, Ass't. Chief, U. S. Forest Service, will discuss the role of federal research in the nation's rapidly expanding economy and the resulting increased demand for wood. He will explore Federal responsibility in utilization research in relation to other public and to industry research. Mr. Harper will outline areas in which new advances need to be made.

Dr. E. C. Jahn, second keynoter, Asst. Dean at the New York State University College of Forestry, will stress the importance of a strong program of research in institutions of higher learning, and will relate this to the lack of adequately trained physicists, engineers and chemists to lay the ground work for developmental research in the wood industry.

The industry viewpoint on research will be discussed by Dr. Winton I. Patnode, Director of Research and Development for the Weyerhaeuser Timber Co., the world's largest lumber and allied forest products company.

Honorary Lecture Planned

Harry D. Tiemann, internationally known seasoning specialist and dean of wood drying in the United States, will present the Charles J. Williams Memorial Seasoning Lecture at the keynote session. "Highlights in the Development of Kiln Drying" is the title of his paper which will encompass the entire span of his career. The lecture is the first honorarium of its kind to be given at an FPRS National Meeting.

Sikorsky to Address Session

Perhaps the best-known international figure to appear before FPRS, Igor Sikorsky will speak on "Current and Future Developments in Helicopters" during the session devoted to Helicopters in Logging. The first to develop a successful helicopter in the Western Hemisphere, Mr. Sikorsky is Engineering Manager of Sikorsky Aircraft, a division of the United Aircraft Corp. One of the pioneers in the aviation industry, Mr. Sikorsky was an important figure through the two world wars and has been honored by many nations, including the United States.

Asst. Sec. Army and Wisconsin Governor to Honor Luncheon

George H. Roderick, Ass't. Sec. of the Army and a veteran of 31 years of executive and production experience in the wood products industry, will address the Official Luncheon, June 24, before an estimated attendance of 500 persons. Sharing honors at the platform with Mr. Roderick will be the Hon. Vernon W. Thomson, Governor of Wisconsin.

An authority on packaging of defense materials, Mr. Roderick is expected to discuss the importance of wood and forest products in the nation's defense.

Fundamental and Applied Research to be Studied

The week-long meeting will have 16 technical sessions that will deal with diverse problems of fundamental and applied research and development—from helicopter logging to lignin and sawdust utilization. The sessions are divided according to the Society's Divisions, with some Divisions planning two sessions.

In the area of fundamental research, some of the topics that will be discussed are: the removal of tannins, phenolic compounds, and cellulose from sawdust for its use as fertilizer; research and development possibilities of by-product utilization from sulphite pulping; and thermosetting adhesives from bark extracts and yield from coniferous tree bark of valuable phenolics that can be used in resin applications.

Some of the practical problems that will be discussed are: mobile radio communication, a newcomer to the forest, and its relation to large logging operations; the air drying of lumber with forced air circulation to reduce shipping weights of dimension lumber; and the preservation of markets through the up-grading of methods and finished products.

FPRS and Madison Welcome You June 22-27

Madison, Wisconsin's capitol, is the site of the FPRS 12th National Meeting, June 22–27. Located on an isthmus between two lakes and close to three others, the city offers scenic attractions and is a center for county, state, and national government activities.

Over 700 persons are expected to attend this year's meeting, General Chairman Robert L. Hiller reported recently. Seventeen technical sessions are planned with more than 80 papers and panel discussions on every phase of wood research and development. Registrants will also have the opportunity to attend problem clinics and discussion meetings of FPRS's 14 subject-matter divisions.

Registration Hours

Meeting headquarters will be at the Hotel Loraine, just off Madison's Capitol Square at the center of the city. Registration desks will be staffed from 2 to 5 pm Sunday, June 22, and from 8 am to 5 pm the rest of the week.

Registration fee is $7 for FPRS members, $10 for non-members, and includes admission to all technical sessions, division meetings, plant tours, and the Paul Bunyan Social Hour, as well as a copy of abstracts of technical papers. Ladies registration fee is $5.

Dedication of FPRS Office Building

The new FPRS Office Building, constructed through contributions and material donations, will be dedicated on Sunday, June 22, from 5 to 6 pm. Located just a short way from the U. S. Forest Products Laboratory, the building will be officially opened in ceremonies that will include F. H. Kaufert, FPRS President, Dr. J. A. Hall, Director, and other representatives of the U. S. Forest Products Lab, W. Jeter Eason, FPRS President-Elect and architect of the building, and the mayor of Madison.

Scheduled for Sunday afternoon and early evening are meetings of the National Executive Board, Industry-Education Committee, Employment Committee, and Membership Committee.

Mid-West Section Hosts Welcoming Reception

Meeting registrants will be guests of the Mid-West Section at an informal get-acquainted reception to be held on Sunday evening from 7 to 9 pm in the Crystal Ballroom of the Loraine Hotel. D. W. Bensend, chairman of the Section, reports that a congenial evening is planned for all meeting registrants and their families.

Keynote Session

The technical program will begin Monday morning (see official Technical Program elsewhere in this issue) with the keynote and official opening session planned for Monday afternoon from 2 to 5 pm. Welcoming remarks will be made by the Mayor of Madison; Dr. Kaufert, Dr. J. A. Hall, and R. L. Hiller, General Chairman. Main speakers will deal with the problem of research, and the Charles J. Williams Memorial Seasoning Lecture will be presented.

Other features of the opening session will be the presentation of the Hitchcock Publishing Co. "Awards of Merit Citations" by V. C. Hogren, vice-president of the firm.

The 12th Annual Business Meeting will begin at 11:30 am Tuesday, June 24, at which time the gavel of the presidency will be turned over to incoming President W. Jeter Eason by F. H. Kaufert.

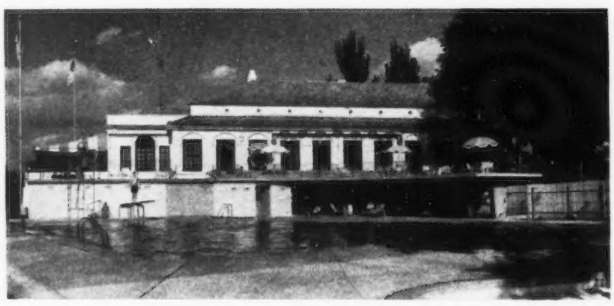
Official Luncheon

Immediately following the business meeting will be the Official Luncheon with Wisconsin Governor Thomson delivering remarks, and Ass't. Secretary of the Army Roderick addressing the assemblage. More than 500 persons are expected to attend the function.

Another feature of the Luncheon will be the presentation of the Vance Publishing Co. "Wood Awards" by J. F. Koellisch, editor and manager of Wood and Wood Products Magazine.

Subject Matter Meetings

Fourteen subject-matter divisions of the Society have scheduled discussion clinics and meetings on Wednesday morning June 24. Meeting from 8 to 10 am will be the Lumber Manufacturing, Wood Preservation, Veneer & Plywood, Quality Control, Industry-



MAPLE BLUFF COUNTRY CLUB and pool where the Official Party and Banquet will be held.

Education, Merchandising, and Packaging Divisions. From 10 am to 12 noon the following divisions will meet: Wood Composition Board, Logging, Chemical Utilization, Wood Drying, Wood Machining, Glues & Gluing and Finishing. (See meeting agenda elsewhere in the green section).

ONE OF THE Style Divers that will appear in the aquacade after the Official Party.

Traditional Paul Bunyan Hour and Banquet

The Paul Bunyan Hour sponsored by industry suppliers will precede the Official Party and Banquet at the Maple Bluff Country Club on Wednesday, June 25. The Social Hour will take place from 6 to 7 pm, and the party will follow at 7:30 and continue until midnight. Entertainment will be provided by a professional water ballet that will feature rythmic swimming, plus comic and style diving.

A SAMPLE of rhythmic swimming to be seen during the aquacade.

FPL Tours

Thursday afternoon, June 26, will be entirely devoted to planned tours of the U. S. Forest Products Laboratory and will feature the gamut of facilities at the government facility as well as displays and exhibits showing the scope of laboratory work.

Individual consultation by appointment with laboratory staff specialists will be held the major portion of Friday, June 27. Consultations can also be arranged for other days during the meeting, and a special appointments desk will be maintained at meeting headquarters for this purpose.

A series of open-house plant and laboratory tours have been arranged for Friday, and registration for these tours will also be facilitated at a special registration desk during the meeting. Registrants can visit the: Allis Chalmers Co., Milwaukee, Wis., Kimberly-Clark Paper Mills, Kimberly, Wis., Mosinee Paper Mills, Mosinee, Wis., The Institute of Paper Chemistry, Appleton, Wis., Marathon Research Laboratory, Rothschild, Wis., Harnischfeger Homes Inc., Port Washington, Wis., and the Hammond Organ Co., Chicago, Ill.

WATER BALLET TROUPE that will perform after the Official Banquet.

Varied Ladies Program Planned

The ladies will begin their social activities with a get-acquainted coffee hour on Monday morning at 9 am. A Luncheon and Style Show at the Edgewater Hotel will be held Monday noon and be followed by a tour of interesting sites around Madison, including the University of Wisconsin.

On Tuesday afternoon, ladies may tour the U. S. Forest Products Laboratory, and an excursion to the Madison zoo is planned for the children. Featured Wednesday afternoon will be a boat trip around Lake Mendota. The program will officially end with an excursion of ladies and children to the Blue Mounds area, which will include visits to the Blue Mounds park, Cave of the Mounds, and Little Norway.

44 Suppliers to "Host" Paul Bunyan Hour

Forty-four wood industry suppliers have contributed $50 each as sponsors of the Paul Bunyan Social hour at the FPRS National Meeting in June. Sponsoring firms will be hosts to registrants and their families at the Social Hour preceding the Official Party and Banquet, June 25, at the Maple Bluff Country Club. The sponsors as of May 1 are:

Algoma Division, U. S. Plywood Corp., Algoma, Wis.
American Cyanamid Co., New York, N. Y.
American Mfg. Co., Tacoma, Wash.
American-Marietta Co., Seattle, Wash.
Arnold Dryer Co., Milwaukee, Wis.
The Bahnson Co., Winston-Salem, N. C.
Bauer Bros. Co., Springfield, Ohio.
The Black Bros. Co., Inc., Mendota, Ill.
The Borden Co., New York, N. Y.
The Carborundum Co., Niagara Falls, N. Y.
Catalin Corp of America, New York, N. Y.
The Coe Mfg. Co., Painesville, Ohio.
Peter Cooper Corps., Gowanda, N. Y.
Diamond Gardner Corp., Chico, Calif.
Disston Division, H. K. Porter Co., Philadelphia, Pa.
The Dow Chemical Co., Midland, Mich.
Fiberesin Plastics Co., Oconomowoc, Wis.
Green Bay Paper & Pulp Co., Green Bay, Wis.
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Hough Mfg. Corp., Janesville, Wis.
Industrial Woodworking, Cleworth Publ. Co., Cos Cob, Conn.
Koppers Co., Inc., Pittsburgh, Pa.
The Lilly Co., High Point, N. C.
Masonite Corp., Chicago, Ill.
Mattison-Greenlee Service Corp., Rockford, Ill.
Mereen-Johnson Machine Co., Minneapolis, Minn.
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Moore Dry Kiln Co., Jacksonville, Fla.
National Casein Co., Chicago, Ill.
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Pacific Lumber Co., Chicago, Ill.
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Protection Products Mfg. Co., Kalamazoo, Mich.
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Simonds Saw & Steel Co., Leominster, Mass.
Solem Machine Co., Rockford, Ill.
Southern Screw Co., Statesville, N. C.
Standard Dry Kiln Co., Indianapolis, Ind.
Synvar Corp., Wilmington, Del.
United States Plywood Corp., New York, N. Y.
Weyerhaeuser Timber Co., Tacoma, Wash.
Williams Patent Crusher & Pulverizer Co., St. Louis, Mo.

Official Technical Program

Forest Products Research Society Twelfth National Meeting

June 22–27, 1958 **Madison, Wis.**

Session I—Wood Composition Board

9:00 a.m., Monday, June 23, Chairman: James R. Roberts, Celotex Corp., Chicago, Ill., Vice Chairman (and Presiding Chairman): A. L. Mottet, International Paper Co., Longview, Wash.

Flapreg—Regin Impregnated Flakeboard—J. W. Talbott, Wash. State Institute of Technology, Pullman, Wash.

Particle Board In View of the Rapidly Expanding Nature of the Industry. Panel Discussion. Moderator: A. L. Mottet, International Paper Co., Longview, Wash. Participants: E. M. Williston, Mgr. Central Development Dept. Weyerhaeuser Timber Co., Tacoma, Wash.; Dr. G. G. Marra, Washington State Institute of Technology, Pullman, Wash.; Dale Schubert, Mgr. Industrial Development Co., Tacoma, Wash.; Kenneth Guenther, Pope & Talbot, Inc., Oakridge, Ore.; Robert L. Bremhorst, Sales Engr., U. S. Plywood Corp.; and W. F. Drees, Sales Mgr., Formica Corp., Cincinnati, Ohio.

Session II—Wood Machining

9:00 a.m., Monday, June 23, Chairman: N. C. Bye, Henry Disston Division of H. K. Porter Co. (of Delaware), Philadelphia, Pa. Vice Chairman: Robert J. Hoyle, Jr., College of Forestry, N. Y. State U., Syracuse.

New Developments on Matchers and Sanders—Alvin Stauber, Sales Manager, Yates-American Machine Co., Beloit, Wis.

New Developments in Planers—Jay C. Petter, vice-president, Buss Machine Works, Holland, Mich.

Presses and Clamps—Robert Gilbertson, Bell Machine Works, Oshkosh, Wis.

Rip Saws and Moulders—Gustaf A. Johnson, Mattison Machine Works, Rockford, Ill.

Shapers & Routers—Earl Pankonin, vice-president and director of engineering, Onsrud Machine Works.

Tenoners & Boring—Kenneth V. White, Greenlee Bros. and Co., Rockford, Ill.

Session IIa—Logging

9:00 a.m., Monday, June 23, Chairman: Fred C. Simmons, Northeastern Forest Experiment Sta., Upper Darby, Pa. Vice Chairman: Paul M. Dunn, St. Regis Paper Co., New York, N. Y.

Radio—Essential Tool of Forestry—Robert W. Olin, Director of Planning, Potlatch Forests, Inc., Lewiston, Idaho.

Integrated Hardwood Logging—C. E. Hein, Chief Forester, Goodman Lumber Division, Calumet & Hecla, Inc., Calumet, Mich.

Timber Quality Evaluation—An Industry 'Must'—C. R. Lockard, Northeastern Forest Experiment Sta., Upper Darby, Pa.

Session III—Keynote Session

2:00 p.m., Monday, June 23, Chairman: Dr. F. H. Kaufert, University of Minnesota, School of Forestry, St. Paul 1, Minn.

Federal Research — V. L. Harper, Ass't Chief, Forest Service, U. S. Dept. of Agriculture, Washington, D. C.

Industry Research — Winton Patnode, Director of Research & Development, Weyerhaeuser Timber Co., Tacoma 1, Wash.

Educational Institution Research—E. C. Jahn, College of Forestry, State University of New York, Syracuse.

Highlights in the Development of Kiln Drying—Harry D. Tiemann, retired specialist on seasoning from the U. S. Forest Products Lab., Madison, Wis.

Session IV—Veneer & Plywood

9:00 a.m., Tuesday, June 24, Chairman: John L. Butler, Hardwood Plywood Institute, Atlanta, Ga. Vice Chairman: John F. Lutz, U. S. Forest Products Laboratory, Madison, Wis.

The Effect of High Temperatures on the Strength of Douglas-fir Veneer—P. L. Northcott, Forest Products Laboratories of Canada, Vancouver, B. C.

Possible Future Products of Veneer—John F. Lutz, U. S. Forest Products Laboratory, Madison, Wis.

The Development of Standard Procedures for Determining Rational Hardwood Veneer Grades—Dr. James S. Bethel, Dir., Wood Products Laboratory, North Carolina State College, Raleigh, N. C.

Changes in Plywood Production.

Session V—Wood Preservation

9:00 a.m., Tuesday, June 24, Chairman: C. S. Walters, Prof., Forest Utilization Research, U. of Illinois, Urbana, Ill. Vice Chairman (and Program Chairman): A. H. Bishop, N. Y. State U. College of Forestry, Syracuse, N. Y.

Can We Preserve Our Wood Markets—C. H. Hoffman, Koppers Co., Inc., Pittsburgh, Pa.

Preservation of Particle Board—Henry A. Huber, Dow Chemical Co., Midland, Mich.

Preservative–Water Repellent Treatments for Wooden Packing Boxes—Dr. A. F. Verrall, Chief of Forest Disease Research, Southern Forest Experiment Station, New Orleans, La.

History and Development of Wood Preservation for Millwork in the United States—Ormie C. Lance, Secretary–manager, Nat'l Woodwork Mrs. Assoc., Chicago, Ill.

Improving Wood's Durability through Chemical Modification—R. H. Baechler, U. S. Forest Products Laboratory, Madison, Wis.

Session VI—Industry-Education

9:00 a.m., Tuesday, June 24, Chairman: James S. Bethel, Director, Wood Products Laboratory, N. C. State College, Raleigh, N. C.

Training for Research and Development Work for the Wood Industries—B. A. Jayne, Yale School of Forestry, New Haven, Conn., and R. W. Wellwood, University of British Columbia, Vancouver, B. C., Canada

A New Look at the Undergraduate Curriculum in Forest Products—D. B. Richards, John Hill, and Wilbur DeVall, Alabama Polytechnic Institute, Auburn, Ala.

Is There a Place for a Vocational Training Program for the Wood Industry?

Opportunities for Cooperative Training Programs in the Wood Products Field—Prof. R. A. Van Bye, U. of Cincinnati, Cincinnati, Ohio

Continuing Education for the Wood Industry—Russell Deckert, N. Y. State University College of Forestry, Syracuse, N. Y.

Session VII—Helicopters in Logging

2:30 p.m., Tuesday, June 24, Chairman: F. C. Simmons, Northeastern Forest Experiment Station, Upper Darby, Pa. Vice Chairman: Paul M. Dunn, St. Regis Paper Co., New York, N. Y.

Uses of Helicopters in Logging — Panel Discussion. *Present and Probable Future Developments in Helicopters* — I. I. Sikorsky, Sikorsky Aircraft, Bridgeport, Conn. *Employment of*

licopters in Forestry—J. G. Townsend, Mgr., Helicopter Div., Spartan Air Sources Ltd., Ottawa, Ont., Can. *Experience with Helicopters in Logging*—Carl Agar, Okanagan Helicopters Ltd., Vancouver Airport, B. C., Can. *Advantages in the Use of Helicopters to Forest Resource Managers*—C. I. Ferris, Director, Air Operations, U. S. Forest Service, San Francisco, Calif.

Session VIII—Glues & Gluing

2:30 p.m., Tuesday, June 24, Chairman: R. F. Blomquist, U. S. Forest Products Laboratory, Madison, Wis. Vice Chairman (and Program Chairman): B. S. Bryant, University of Washington, College of Forestry, Seattle, Wash.

Exterior Weathering Studies of Fortified Urea–Resin Glues—R. F. Blomquist and W. Z. Olson, U. S. Forest Products Laboratory, Madison, Wis.

Thermosetting Adhesives from Bark Extracts—Dr. L. H. Bock and Franklin W. Herrick, Olympic Research Division, Rayonier, Inc., Shelton, Wash.

Surface Properties of Wood as Related to Joint Strength—J. E. Marian, University of California, Forest Products Laboratory, Richmond.

Industry Uses of an Automatic Machine for the Rapid Evaluation of Plywood Glue Bonds—B. S. Bryant, University of Washington College of Forestry, Seattle.

Developments in the Application of Adhesives.

Session IX—Quality Control

2:30 p.m., Tuesday, June 24, Chairman: Charles Latimer, Nickey Bros. Inc., Memphis, Tenn. Vice Chairman (and Program Chairman): A. C. Barefoot, N. C. State College, Raleigh, N. C., and Program Chairman: Aubrey Wylie.

Organization of a Quality Control Program—Ross Martin, Sears, Roebuck & Co., Chicago, Ill.

The Statistical Bases for Control Charts—Edward R. Hansen, Hamilton Mfg. Co., Two Rivers, Wis.

A Review of Methods for the Sampling of Timber—R. G. Pearson and E. J. Williams, C. S. I. R. O., Australia.

Statistical Quality Control in Logging Cost Control—L. J. Lussier, North Shore Paper Co., Can.

Statistical Control of Grade Yields of Lumber from Hardwood Logs—A. C. Barefoot, and R. M. Carter, North Carolina State College, Raleigh.

Cost Reduction Through Methods Improvement—George Vasiliou, Cleveland, Ohio.

Session X—Wood Composition Board (2)

2:00 p.m., Wednesday, June 25, Chairman: James R. Roberts, Celotex Corp., Chicago, Ill. Vice Chairman: A. L. Mottet, International Paper Co., Longview, Wash.

New Types and Uses of Hardboard.

The Steineman Process for Making 3/4 inch Particle Board with a 3-minute Press Cycle—E. Sigurd Johnson, N. C. State College, Raleigh.

Medium Density Board.

Dry Process Hardboard—John G. Robinson, Bowaters Board Co., Calhoun, Tenn.

Session XI—Wood Drying

2:00 p.m., Wednesday, June 25, Chairman: S. B. Preston, School of Natural Resources, University of Michigan, Ann Arbor. Vice Chairman (and Program Chairman): John McMillen, U. S. Forest Products Laboratory, Madison, Wis.

Fundamental Research
McMillen, Chairman

Factors Associated with the Development of Collapse During Kiln Drying of Aspen Lumber—Dr. Arne Kemp, Head, Dept. of Forestry, Stephen F. Austin State College, Nacagdoches, Texas.

Factors Influencing the Permeability of Softwood During Impregnation and Drying—John P. Krier, School of Forestry, Montana State University, Missoula.

Some Aspects of Drying Wood at Temperatures Above 100° C.—Prof. John L. Hill, Alabama Polytechnic Institute, Auburn.

Applied Research
Walton Smith, Chairman

Air Drying of 4/4 Red Oak Flooring Stock in Southern Wisconsin—Edward C. Peck, U. S. Forest Products Laboratory, Madison, Wis.

Roof your Lumber and Increase Your Profits — Wendell Clark and Thomas M. Headlee, Carbondale Forest Research Center, Central States Forest Experiment Station, Carbondale, Illinois.

Air Drying Western Softwoods with Forced Air Circulation—Jack R. Pfeiffer, Oregon Forest Products Research Center, Corvallis.

Operation Predry—Variables in Drying Southern Pine—Louis I. Gaby, Athens-Macon Research Center, Southeastern Forest Experiment Station, Athens, Ga.

Session XII—Wood Finishing

2:00 p.m., Wednesday, June 25, Chairman: F. H. Thomas, Sherwin-Williams Co., Chicago, Ill. Vice Chairman: D. G. Lubeck, Hammond Organ Co., Chicago, Ill.

A New Tool for Measuring the Adhesion of Surface Coatings to Wood Products—Bruce O. Hallberg, Weyerhaeuser Timber Co., Longview, Wash.

Steineman Machine for Flow Coat Application of Lacquers, Synthetics, Polyesters—E. Sigurd Johnson, N. C. State College, Raleigh.

An Experimental Study of Means for Measuring the Surface Smoothness of Wood—Armin Elmendorf, Elmendorf Research Inc., Palo Alto, Calif.

The Prefinishing of Plywood with a Vinyl Overlay—W. Jeter Eason, vice president, Nickey Bros., Inc., Memphis, Tenn.

Session XIII—Chemical Utilization

2:00 p.m., Wednesday, June 25, Chairman: A. S. Gregory, Mgr. of Central Research Dept., Weyerhaeuser Timber Co., Longview, Wash. Vice Chairman (and Program and Presiding Chairman): Irwin A. Pearl, Institute of Paper Chemistry, Appleton, Wis.

The Production of Torula Yeast from Spent Sulfite Liquor—Jess Holderby, vice president, Lake States Yeast Corp., Rhinelander, Wis.

Microbiological Utilization of Wood Sugars—George Hajny, U. S. Forest Products Laboratory, Madison, Wis. (by title only).

Alcohol Production from Spent Sulfite Liquor—Carter A. Watson, Technical Director, Puget Sound Pulp & Timber Co., Bellingham, Wash.

The Value of Wood Waste in Promoting Plant Growth—Stewart Dunn and Judith D. Emery, Agricultural Experiment Station, Durham, N. H.

Fermentative Action of Isolated Rumen Organisms on Wood Substrates—Don Stranks, Forest Products Laboratories of Canada, Ottawa, Ont.

Preparation and Uses of Sawdust Compost—Prof. Sergius S. Wilde, University of Wisconsin, Madison.

Session XIV—Lumber Manufacturing

9:00 a.m., Thursday, June 26, Chairman: Milton H. Mater, Mater Engineering, Corvallis, Ore. Vice Chairman: E. P. Ivory, president, Ivory Pine Co., Dinuba, Calif.

Lumber Packaging & Shipment by Rail—Joseph Buchalter, Weyerhaeuser Timber Co., Longview, Wash.

Saw Mill Lumber Handling—Nels Glesne, President, Casswood Industries, Inc., Beardstown, Ill.

How Packaging Lumber Saves Time and Money—Jesse C. Fowler, Haiming Lumber Co., Williams, Arizona.

Session XV—Chemical Utilization (2)

9:00 a.m., Thursday, June 26, Chairman: A. S. Gregory, Mgr. of Central Research Dept., Weyerhaeuser Timber Co., Longview, Wash. Vice Chairman (and Program Chairman): Irwin A. Pearl, Institute of Paper Chemistry, Appleton, Wis. Presiding Chairman: Dr. J. A. Hall, U. S. FPL, Madison, Wis.

By-Product Utilization from Sulfite Pulping—J. R. Salvesen, Marathon Division, American Can Co., Rothschild, Wis.

Technical and Economic Aspects of Furfural Production from Hardwood—Frederick G. Perry, Jr., Joseph J. Voci, and R. Claire Canty, Arthur D. Little, Inc., Cambridge, Mass.

Newer Activities of National Council for Stream Improvements Re: Air Pollution—Russell O. Blosser, National Council for Stream Improvement, New York, N. Y.

Steam Pollution Control Activities in Wisconsin—Theodore F. Wisniewski, Director, Wisconsin Commission on Water Pollution, Madison.

Charcoal Briquetting — Paul D. Haigh, vice president, Komarek–Greaves & Co., Chicago, Ill.

Session XVI—General

9:00 a.m., Thursday, June 26, Presiding Chairman: J. F. Hamilton, Michigan College of Mining and Technology, Houghton.

How to Build Better Wood Houses with Today's Materials—John Reno, Pacific Lumber Co., Chicago, Ill.

Commercial Possibilities of Forests of the Amazon Region — Llewelyn Williams, Randolph, Wis.

Diffusion of Bound Water through Wood Substance—Dr. A. J. Stamm, U. S. Forest Products Laboratory, Madison, Wis.

The Challenge of the Overhead Door—Ralph Casselman, Engineering Products & Service Co., Washington, N. J.

An Electron Microscope Investigation of Pit Membrane Structure in Conifers and Hardwoods.

Convention Registrants Urged to Attend Division Meetings

Registrants at the 12th National Meeting in Madison will have the opportunity to attend meetings of the 14 Divisions on Wednesday, June 25. Seven meetings will be held concurrently from 8:00 to 10:00 A. M., with seven others scheduled from 10:00 to 12:00 noon.

The first group will include the following divisions: Lumber Manufacturing, Wood Preservation, Veneer & Plywood, Quality Control, Industry-Education, Merchandising, and Packaging. Meeting in the second group will be the Wood Composition Board, Logging, Chemical Utilization, Wood Drying, Wood Machining, Glues & Gluing, and Finishing Divisions.

Although diverse in subject-matter content, the Divisions share the objective of stimulating discussion and encouraging the development of new and improved wood processes and products. A major need of the Divisions, according to F. J. Rovsek, Executive Secretary, is in the area of increased organizational development to allow further and continuous carrying out of objectives throughout the year.

Other areas in which the Divisions are active are in creating technical programs for the national meetings, summarizing developments and progress made in respective fields for the Annual Review issue of the JOURNAL, assisting the Society's 14 Sections in program development, providing technical information requested through the National Office, and compiling and preparing bibliographies, manuals and so forth, for publication either in the JOURNAL or as separate entities.

Committee Agendas

Wood Preservation

Chairman: C. S. Walters

1. Plans for technical session at the 1959 National Meeting.
2. Installation of new officers.
3. Presentation of the first draft of a report on "Wood Preservation Activities in the United States in 1957" (Division Chairman).
4. New business.

Veneer and Plywood

Chairman: John L. Butler

1. Plans for the Annual Report.
2. Discussion concerning technical session for 1959 Annual Meeting.
3. Special problems to be proposed by persons attending meeting.

Quality Control

Chairman: Charles Latimer

1. 1959 Meeting.
   - A. Theme
   - B. New developments of possible interest.
   - C. Routine of setting up program.
2. Annual Review.
   - A. Methods of obtaining adequate coverage of the field.
   - B. Areas to be covered.
3. Discussion of Division objectives.
4. Committee Problems.
   - A. How can the committee best be kept informed of new applications of quality control techniques?
   - B. How can the organization of the committee be improved?

Packaging

Chairman: A. R. Tegge, Jr.

1. Division reorganization.
2. Recommendations to the FPRS Executive Board concerning continued activity of the Division.

Wood Composition Board

Chairman: James R. Roberts

1. Annual Review.
2. Program for 1959 National Meeting.
   - A. Discussion of production of intermediate density boards for structural purposes and how to cover it in a program.

Logging

Chairman: F. C. Simmons

1. Report on activities for the past year.
2. Discussion on bibliography project.
3. Proposals for activities for the coming year.
4. Election of Chairman and Vice-Chairman for coming year.
5. Membership of Steering Committee.

Chemical Utilization

Chairman: A. S. Gregory

1. Welcome by Committee Chairman and introduction of officers and those attending the meeting.
2. Report on program by Vice-Chairman, I. A. Pearl.
3. Old business.
4. New business.
   - A. Objectives, scope, functions, and methods of operation of Chemical Utilization Committee.
     1. Report of sub-committee (C. C. Heritage).
     2. Discussion of sub-committee's report.
     3. Formal establishment of Committee policy.
   - B. Appointment of new committees.
5. Introduction of officers for 1958–1959.

Wood Machining

Chairman: N. C. Bye

1. Discussion of Division organization.
2. Setting up steering committee to support the over-all activities of the Division.
3. Appointment of 1959 Annual Program Committee and discussion of suggestions for topics and papers.
4. Appointment of 1958–59 Annual Industry Report Committee.
5. Appointment of Saw and Knife Standardized Nomenclature Committee.
6. Appointment of Nominating Committee.
7. New business.

Glues and Gluing

Chairman: R. F. Blomquist

1. Subcommittee Reports and Discussions to carry on beyond material in the 1957 Annual Review and to prepare for the 1958 Annual Review.
   - A. New adhesives and bonding processes for wood.
   - B. New gluing techniques and new glued wood products.
   - C. New work in developing test methods for glues and glued products.
   - D. New gluing equipment.
   - E. Special research studies of glues and gluing (recent), and needs for the future.
   - F. New literature on glues, gluing, and glued products.
2. Consideration of reorganization of the subcommittees.
3. Plans for the 1959 Technical Session.

On The Cover

W. Jeter Eason, Next President of FPRS

Mr. W. Jeter Eason's first position in FPRS was in 1951, when he was elected vice chairman of the Deep South Section. He and other officers of the group succeeded in instilling new spirit into the Section, which had been declining in membership and activity. In 1952, as plans were drafted for the 1953 National Meeting in Memphis, Tenn., Mr. Eason was invited to take charge of arrangements in Memphis. As a result of his services, he was elected National Executive Board Member in 1953 for a three-year term, representing the South-Central Region. Late in the same year, the Society decided to establish a permanent home

Mr. Eason, Cont'd.

office building in Madison, Wis., and Mr. Eason, an engineer and architect by profession, offered the services of his architectural firm to design the building.

After completing three years as a Board Member, he was nominated for the office of vice president of the Society, to which position he was elected in June 1956 at Asheville, N. C. In 1957 he was nominated and elected president-elect of the Society, and also served as chairman of the Society's Budget and Finance Committee. He is currently Technical Program Chairman for the 12th National Meeting, and at the convention in June will become president of FPRS, climaxing eight consecutive years of elected activity in FPRS.

As vice president of Nickey Bros. Inc., Memphis, Tenn., Mr. Eason is well known for his encouragement of fundamental as well as applied research. Quick to recognize the significance of new developments, Mr. Eason and Nickey Bros. worked closely with the U. S. Forest Products Laboratory on the commercial development of Impreg. Nickey Bros. is now the largest manufacturer of this material, which has greatly improved model-making processes for the automobile industry.

Mr. Eason was also instrumental in development of a new industrial material called Dendrol, which displayed properties that would allow its use in the thermosetting of phenolic resins. Produced from wood residues, commercial use of this product still lies in the future.

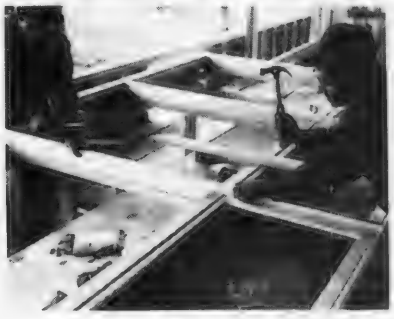
Constantly aware of new advances and changing conditions, Mr. Eason recently suggested (in a paper to the Hardwood Plywood Institute) numerous changes in merchandising and technology to help the industry remain competitive with other raw materials and substitutes. Mr. Eason is a graduate of the Carnegie Institute of Technology. He is also president of the architectural firm of Eason, Anthony, McKinnie, and Cox, Memphis, Tenn.

FPRS Directory Announced

An alphabetical directory of FPRS members will soon be released, F. J. Rovsek, executive secretary of the Society, reports. The last directory issued was in February 1957 and was geographic in accordance with Society policy to publish geographic and alphabetical directories in alternate years. Members who desire a copy of the directory may place their request with the national office.

Photo Progress Report

Monthly Growth of the FPRS Office Building



Window installation was carried out as building construction entered the later stages. Completely installed rear windows are shown in top photo. Representing $2,000 worth of donation, the windows were contributed by Carr, Adams & Collier, Dubuque, Iowa. Harvey Gill and other firm officials (above left) discuss window installation with Otto Heyer, supervising architect. Window assembly proceeded quickly after delivery (above right, and right).

Another major donation was the softwood plywood, including exterior sheathing, contributed by the Roseburg Lumber Co., Roseburg, Ore. The contribution consisted of 1500 square feet of 5/8 inch Plyscord and 950 square feet of 3/8 inch Plyscord. Application of the exterior sheathing is shown below. Stone work has also been started (top and bottom photos).

With completion of the building expected in June, dedication ceremonies will be held Sunday, June 22, the first day of the FPRS 12th National Meeting in Madison.

Over 100 Persons Contribute to FPRS Meeting

Meet some of the authors, session chairmen, officers and committee members who are contributing effort toward the success of the FPRS 12th National Meeting. Sixteen technical sessions with more than 80 papers and panel discussions are planned.

C. AGAR

J. J. ALLEGRETTI

R. H. BAECHLE

A. C. BAREFOOT

R. H. BERRY

J. S. BETHEL

A. H. BISHOP

R. F. BLOMQUIST

R. O. BLOSSE

L. H. BOCK

B. S. BRYANT

J. BUCHALTER

J. L. BUTLER

N. C. BYE

R. C. CANTY

R. CASSELMAN

W. P. CLARK

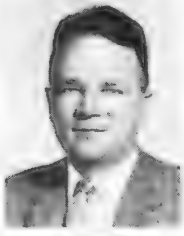
F. E. DICKINSON

R. C. DuBRUCO

S. DUNN

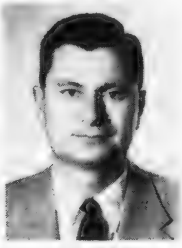
W. J. EASON

A. ELMENDORF


C. FERRIS

L. J. FITZPATRICK

J. C. FOWLER


L. I. GABY

G. G. GARLI

N. GLESNE

A. S. GREGORY

P. D. HAIGH

G. HAJNY

J. A. HALL

B. O. HALLBE

F. HAMILTON

E. R. HANSEN

E. S. HARRAR

C. A. HART

I. HATFIELD

T. M. HEADLEE

F. W. HERRICK

J. L. HILL

R. L. HILLER

C. H. HOFFMAN

J. HOLDERBY

H. A. HUBER

W. L. IRWIN

B. A. JAYNE

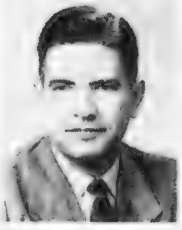
E. S. JOHNSON

G. A. JOHNSON

F. H. KAUFERT

A. KEMP

W. A. KLUENDER



J. P. KRIER

O. C. LANCE

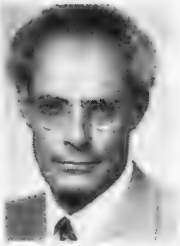
P. H. LANE

C. LATIMER

C. R. LOCKARD

L. J. LUSSIER

J. F. LUTZ



J. E. MARIAN

G. G. MARRA

M. H. MATER

J. M. McMILLEN

A. L. MOTTET

G. E. NASLUND

T. W. NOBLE

P. L. NORTHCOTT

N. A. NORTON

R. W. OLIN

W. Z. OLSON

E. PANKONIN

R. D. PAULEY

I. A. PEARL

R. G. PEARSON

E. C. PECK

F. G. PERRY, JR.

J. C. PETTER

J. R. PFEIFFER

S. B. PRESTON

J. RENO

D. B. RICHARDS

J. R. ROBERTS

J. R. SALVESEN

D. K. SAUNDERS

F. C. SIMMONS

A. J. STAMM

A. STAUBER

D. W. STRANKS

F. H. THOMAS

J. G. TOWNSEND

C. TRINKLE

G. VASILIOU

T. S. VEAZEY, JR.

A. F. VERRALL

J. J. VOCI

C. S. WALTERS

W. R. WARNER

C. A. WATSON

R. W. WELLWOOD

S. A. WILDE

E. J. WILLIAMS

L. WILLIAMS

E. M. WILLISTON

T. F. WISNIEWSKI

A. E. WYL

Elections and Awards Winners Reported by Eastern Canadians

New officers were elected and winners of the Spring 1958 Awards Competition were chosen by the Eastern Canadian Section in recent action, according to Section officials.

Officers for 1958–59 are: G. Billington, Moore Dry Kiln Co. Ltd., chairman; R. F. DeGrace, Canadian Institute of Timber Construction, vice chairman and secretary; C. Allgeier, Dominion Electrohome Ltd., second vice chairman; and J. A. Doyle, Forest Products Laboratories of Canada, treasurer.

Winning students, their university affiliation, and paper titles for the Awards Competition are: A. W. Porter, U. of New Brunswick, "The Kiln-Drying of Lumber"; W. D. Leach and J. D. Fox, N. S. Technical College, "Design for Fink Truss in Wood"; M. Cantin, Laval U., "The Effect of Sodium Chlorite and Sodium Sulphite on the Strength of Wood"; and D. Bates, U. of Toronto, "Management Plan for Block 2 of the University Forest, Dorset".

The Section awards were created for the purpose of encouraging interest in wood and its intelligent use among universities and university students. Contributors to the prize fund are: International Panel Boards Ltd.; General Woods and Veneers Ltd.; Abitibi Power and Paper Co.; Forano Ltd.; Canada Creosoting Co. Ltd.; Monsanto Canada Ltd.; Moore Dry Kiln Co.; Reichhold Chemicals Ltd.; Quebec Lumber Mfgs. Assoc.; Booth Lumber Co. Ltd.; Preston Woodworking Co.; Dominion Electrohome Industries Ltd.; Canadian Institute of Timber Construction; and the Knight Mfg. & Lumber Co. Ltd.

Wood Utilization Processes and Particle Board Markets Planned for Study by TECO

A new research advisory committee to the Timber Engineering Co. met recently at Point Clear, Ala. The committee will advise the TECO research laboratory on future research planning. The 14-man committee includes representatives from industry, university, and public research laboratories.

The program for the future includes a cooperative research project with lumber manufacturers and users, on wood utilization processes. The data developed will be analyzed to aid lumber producers to appraise the opportunities for a greater number of salable products from their raw material resources.

Another project planned by the Timber Engineering Co. will be a special market survey on particle board, to furnish clients with information that will enable them to appraise outlets for particle board that are unexploited, determine the suitability of boards for specific end uses, or serve as a warning that the potential of certain markets or end uses is not sufficient to warrant production.

To be a cooperative group survey, the investigations will be conducted in this country and Europe, and interviews will be scheduled with particle board manufacturers, wholesale and retail merchants, and consumers. A confidential report will be issued to sponsoring clients at the conclusion of the survey. More information on the two cooperative programs can be obtained from the Timber Engineering Co., 1319-18th St., N. W., Washington 6, D. C.

Coated Abrasive Machinery To be Exhibited June 10–13

Fifty-five manufacturers of coated abrasive machine tools will demonstrate new products at the Third National Coated Abrasives Machinery Show, June 10–13, Troy, N. Y. The show will take place at Behr-Manning Co., sponsors of the event.

All machines will be in full operation and production men are invited to bring actual workpieces to test on the machines. Dedication of Behr-Manning's million-dollar, new Product Engineering building will precede the meeting, on June 9.

Chemical Firm Takes New Name

Allied Chemical Corp. is the new name taken by the Allied Chemical & Dye Corp., officials announced recently. The firm operates 12 laboratories employing more than 1600 chemists and technicians. An estimated two-thirds of the company's research budget goes into development of new products and processes, and one-third for improvement of existing products and for fundamental and applied research.

Construction Begins on Resin Research Center

Construction on a new million-dollar synthetic resin research center has been started, according to American-Marietta Co., Harbor Is., Seattle. The center will add more than 30,000 square feet to the present research and administrative building, which covers about 8,500 square feet. The present facility will be completely renovated.

The resin center will consist of 21 unit laboratories and six process development areas, with areas and equipment for the evaluation of wood products manufactured throughout the Northwest. The building will utilize various engineered forest products for both structural and aesthetic values.

FPRS Salutes . . .

Men Contributing Time and Efforts for Furtherance of the Society and Wood Industry.

W. C. LEWIS

Wayne C. Lewis—Open house plant tours and consultation arrangements with U. S. Forest Products Laboratory specialists for meeting registrants are Mr. Lewis's responsibilities for the National Meeting. Mr. Lewis plans to have a special desk at meeting headquarters where persons can register for the tours and laboratory consultations.

With a B.S. in civil engineering from the University of Wisconsin, Mr. Lewis is on the staff of the U. S. Forest Products Laboratory, where he is an engineer in the Division of Physics and Engineering. He is a past chairman of the Mid-West Section. An authority on the economics of hardboard and particle board technology, Mr. Lewis represented the U. S. at the International Consultation on Particle Board in Geneva.

A. M. MUCKS, JR.

Arlie M. Mucks, Jr.—has marshalled community cooperation for the National Meeting Committee. As manager of the Convention and Promotion Division of the Madison Chamber of Commerce, he has attended FPRS committee meetings and given advice and time to help make the Madison meeting a success. Largely through his efforts, firms in Madison and the State are contributing mementos and souvenirs for the meeting.

A graduate of the University of Wisconsin with a major in economics, Mr. Mucks, prior to his present position, worked in retail sales and sales promotion. A pilot during the second world war, he is currently active as commander of the 115th Air Base Squadron, Wisconsin Air National Guard. He is president of one the city's P. T. A.'s.

F. A. STRENGE

Frederick A. Strenge—has provided one of the able pens for publicity of the National Meeting in June. With a long career of writing experience behind him, he has composed news releases for journals and the local and state press. As a member of the Publicity Committee he has worked in close cooperation with Gardner Garlick, chairman of the committee.

Mr. Strenge is head of the editing section at the U. S. Forest Products Laboratory. He is a graduate of the University of Wisconsin with a degree in journalism. Before joining the laboratory, he was a reporter and editor for newspapers in Madison, Wisconsin Rapids, and Milwaukee. He also wrote for magazines and trade journals

Statistics Course Offered in North Carolina Starts June 16

A one-week short course in statistical methods for research workers in industry and the physical sciences will be held the week of June 16 at Brevard College, Brevard, N. C. The course is sponsored by the Institute of Statistics at N. C. State College.

Both elementary and advanced sections of the course will be offered. Basic concepts. confidence limits, tests of significance, correlation and curve fitting, analysis of variance, and an introduction to design of experiments will be covered in the elementary section.

Among the topics included in the advanced course are variance components, multiple regression, response methods, and experimental design. Enrollment for both courses is limited to 50 students for each section, and a registration fee of $125.00 will be charged. More information is available from the Division of College Extension, Box 5125, State College Station, Raleigh, N. C.

Building Expansion Program Started by Machinery Firm

The first phase of a six-year Solem and Merritt-Solem expansion and relocation program estimated at three to four million dollars has been started in Rockford, Ill., firm officials announced recently. A half-million dollar building is now being erected that will have approximately 50,000 square feet of floor space. Eventually, the firm's entire machine manufacturing operations, including their Lockport, N. Y. Plant, will be consolidated at Rockford.

Final Timber Resource Review Released by Forest Service

Forty years from now we will have to grow twice as much timber as we do today in order to supply wood for an increased population, according to "Timber Resources For America's Future", a report recently released by the U. S. Dept. of Agriculture.

The 700-page book contains the results of a nation-wide survey and study made by the Forest Service in collaboration with State Foresters, other state agencies, forest industries, and many public and private organizations.

The book makes an appraisal of the Nation's timber situation and probable timber demands in the future. Four ways for increasing future timber supplies are outlined. They are: to plant 52 million acres, approximately the size of Maryland, Indiana, and Maine; greater control of fire, insects, disease, and other destructive agents; improvement of timber utilization; and improvement of lands currently cut over.

Millwork Home Study Course Developed by Michigan State U

A home-study course in millwork has been developed by the continuing education service of Michigan State University for the Northern Sash & Door Jobbers Assoc. The course was composed by Prof. William B. Lloyd, following a grant of $5,500 to the university by the association for this purpose. The course will be administered by the University.

Designed as a six-month study course leading to a Certificate of Completion, subjects covered are: properties of wood; fundamentals of construction; mouldings and their uses; door frames and entrances; sash, windows, and window units; glass and glazing; door, exterior and interior; stair work and stair design; fireplace mantels; kitchen cabinets; and stock millwork estimates.

Enrollment for the course is $49.50 per person. Materials include a text and study guide, a reference blueprint, moulding catalogs, wood handbook, handbook on frame house construction, and a set of house plans. More information can be obtained by writing the Secretary, Northern Sash & Door Jobbers Assoc., 11 S. La Salle Street, Chicago 3, Ill.

See page 46-A for New Products—Literature

EMPLOYMENT SERVICE

The FPS Employment Service is operated without charge as a service to members. Companies or institutions with positions to be filled or individuals seeking employment may participate in this program by inserting a free ad in two consecutive issues of the FOREST PRODUCTS JOURNAL. Inquiries concerning employment listings or ads to be placed in the JOURNAL should be addressed to FPRS Employment Service, P. O. Box 200, University Station, Madison 5, Wis. Correspondence is kept confidential.

E–309—Large British firm with timber concessions in the British Crown Colony of North Borneo, exporting both sawn timber and logs, requires experienced sawmill manager to supervise two modern mills. Operation is located in the city of Sandakan. Housing is furnished, paid home leave every two years, education allowance for children, retirement benefits. Reply stating age, experience, salary requirements. All replies confidential. (June)

E–311—Position as assistant superintendent for flooring firm available. Engineering training or degree, and experience in veneer and plywood operations desirable. Knowledge of moisture controls, glues, lamination processes, and finishing desired. Will be responsible for improvements in quality, material handling, and line production. Salary commensurate with background and ability. Send resume outlining qualifications and personal history. (May)

Employment Wanted

No. 462—Sales position desired in wood products industries. Holds a BS in Business Administration, and is experienced as an industrial engineer in the plywood field. (May)

No. 466—Position desired in product development or production in wood products. Has four years of college training in general forestry, and several months experience in office and field work in government and private agencies associated with forest products. (May)

No. 467—Executive engineer desires position in development, production, or management. Has 14 years of experience in pulp, paper, and wood products industries, including 7 years in design, construction, and operation of particle-board plants. Now associated with consulting firm but desires more direct participation in industry. (May)

No. 468—Position desired in wood products industry. Holds BS in Forest Utilization. Army duty terminates July, 1958. Prefers Colorado, California, or Pacific Northwest location. (June)

No. 469—Position in research or product development desired. Holds degree in wood utilization from Michigan State University. Prefers Northeast or Mid-West location. (June)

No. 470—Position desired in buying, selling, or production aspect of a wood products organization. Previous experience includes timber cruising, marking, surveying, logging, and nine months of government research in log and tree grading. Holds BS in Forestry from West Virginia University. Presently attending John W. McClure Inspection Training School of NHLA. Available mid-July. (June)

OPPORTUNITY IN PRODUCT DEVELOPMENT

Stimulating and challenging positions are opening up in the expanding Research and Development Department of a leading producer of fiber insulation products, both blanket and board. At this time there is a responsible position open in the Product Development Section:

Product Development Engineer—Work relates to selection, development, and field trial evaluation of products designed for present and new markets in building products fields or industrial markets for fibrous products. Applications should have interest in all phases of product development from idea stage through commercial production. Varied and expanding program will include travel, consumer contacts, and liaison with Sales. College graduate with architectural or other technical background and 4–8 years experience is preferred

Salary commensurate with education and experience.

Applicants should submit a complete resume' of personal data, educational background, work experience and references to:

Research and Development Departme
WOOD CONVERSION COMPANY
Cloquet, Minnesota

Get IN LINE with today's gluing trend!

SWITCH TO RCI's 9153 PLYAMUL

• Want to know why the woodworking industry is turning from animal glues to RCI's 9153 PLYAMUL for an increasing variety of applications?

Always ready for use and easy to apply, this quick-setting Reichhold polyvinyl acetate adhesive permits continuous operation of automatic equipment. Because it does not "cake" like animal glues, fewer costly shutdowns for cleaning are required.

In addition to gluing furniture joints, versatile 9153 PLYAMUL is recommended for bonding plastic overlay and phenolic-impregnated backing sheets to particle board, plywood and lumber panels; for edge-gluing lumber cores; for no-clamp production of hollow-core doors; and for laminating waste lumber parts into marketable products.

For complete information on 9153 PLYAMUL, write to Reichhold today for Technical Bulletin G-11.

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Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenol
Hydrochloric Acid • Formaldehyde • Glycerine • Phthalic Anhydride
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RCI *Creative Chemistry . . .*
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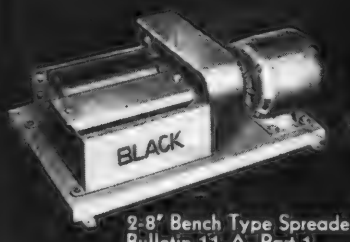
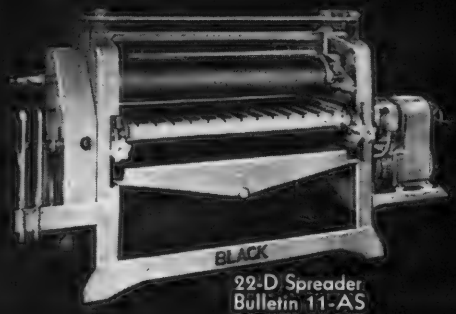


2-8′ Bench Type Spreader
Bulletin 11-A, Part 1



22-D Spreader
Bulletin 11-AS

No. 567 Spreader
Bulletin 11-A, Part 2

Case Clamp
Bulletin 11-J

First in Production, Quality, Economy

BLACK BROTHERS EQUIPMENT

. . . for gluing, clamping, laminating

GLUE SPREADERS

The most complete line in the world—for hot or cold glues. Single or double spreaders from 8″ through 122″ roll widths.

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Cold Glue Mixers—10 to 400 gal.; Portable Motor Driven Cold Glue Mixers—2 to 15 gal. Glue Heaters for steam, electric or gas heat—2½ to 125 gal.; Portable Pot Glue Heaters.

COLD PRESSES

A wide line of high-production presses: Rotary-type; Air-Hose; Electric, Hydraulic and Hand Power Laminating Presses. Efficient, accurate, economical.

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A production clamp for every need: Case Clamps—hand-powered or pneumatic, revolving or stationary; Clamp Carriers; Sash, Frame and Door Clamps.

THE BLACK BROTHERS CO., INC.

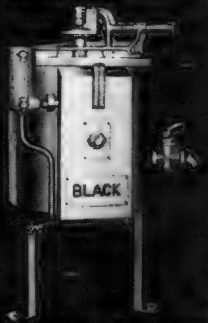
MENDOTA 8, ILLINOIS

Cold Glue Mixer
Bulletin 11-I

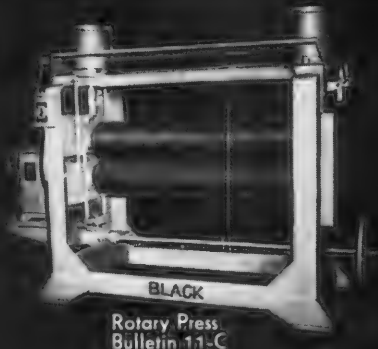
Clamp Carrier
Bulletin 11-K

Portable Glue Mixer
Bulletin 11-IS

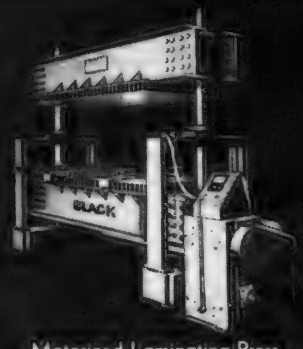
Sash, Frame and Door Clamp
Bulletin 11-M



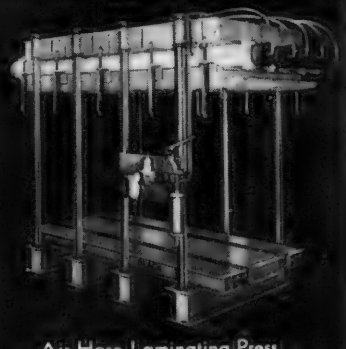
No. 700 Series Glue Heater
Bulletin 11-H



Rotary Press
Bulletin 11-C



Motorized Laminating Press
Bulletin 11-E



Air Hose Laminating Press
Bulletin 11-D

FPRS Forest Products Journal

Vol. VIII, No. 5
May, 1958

Curing Rates of Resorcinol and Phenol-Resorcinol Glues in Laminated Oak Members[1,2]

M. L. SELBO

Chemical Engineer, Timber Processing Division, Forest Products Laboratory 3, Forest Service, U. S. Department of Agriculture

Curing rates were studied for two phenol-resorcinol and three resorcinol glues. Data on time-temperature combinations that will develop adequate glue bonds in white oak are presented in both tabular and graphic forms.

CURING REQUIREMENTS FOR GLUES have often been determined by results gained in the hot-pressing of plywood. In such relatively thin panels, the glue can be cured at high temperatures in a comparatively short time. As a rule, this is not feasible with heavy laminated members, except possibly by high-frequency heating. High-frequency heating, however, has not yet found much application for curing glues in heavy laminated members, at least in members of dense species such as white oak. Furthermore, the information developed in conjunction with thin plywood is usually not directly applicable to laminates of dense species.

Very little has been published on the curing requirements of resorcinol and phenol-resorcinol glues for use in laminating. Such information would be helpful to the growing laminating industry.

There is no evidence that curing periods of as much as 24 hours at the temperatures commonly obtained in dry kilns or similar curing chambers are harmful to these glues, but for economic reasons it is important to reduce the curing period to the minimum time consistent with the joint durability required by the service conditions.

In some of the earlier work at the Forest Products Laboratory on phenol-resorcinol glues (when little was known about the curing requirements of these glues), oak beams were glued and cured at various temperatures from 110° to 210° F. The initial test results on those beams cured at the lower temperatures showed mediocre to poor joint quality, but when tests were made on some of the same beams a year later, the results indicated great improvement. The improved results were obtained from beams that had been well painted and then soaked at room temperatures in a 4 per cent sodium chloride solution for about a year. This soaking was done to simulate sea-water conditions.

Table 1.—RESULTS OF DELAMINATION TESTS[1] ON LAMINATED WHITE OAK BEAMS GLUED WITH GLUE A AND CURED FOR VARIOUS PERIODS AT 80°, 100°, 110°, 130° AND 150° F. (GLUE-LINE TEMPERATURES)

Curing temperature °F.	Curing time Hours	Delamination Per cent
80	72	84.0
	336	18.6
	1,008	6.5
	2,016	1.6
100	22	27.3
	214	5.2
	358	2.6
	526	1.6
110	1	23.3
	4	13.0
	9	8.1
	15	5.0
	20	4.1
130	1/12	9.7
	1	6.2
	3	4.7
	5	4.1
150	1/12	5.5
	1	1.1
	3	1.4

[1] Conducted according to ASTM D1101-53, "A Method for Testing the Integrity of Glue Joints in Laminated Wood Products for Exterior Service."

Beams cured at the lower temperatures and exposed unpainted to the weather developed serious delamination. This indicates that curing temperatures as low as 110° F. on oak were inadequate when the glued beams were subjected to severe exposure, but that the bond continued to improve where adequate protection against shrinkage and rapid swelling was provided.

The results mentioned indicated a need for further study of the time-temperature relationships involved in curing resorcinol and phenol-resorcinol glues in laminated members.

This paper presents data on time-temperature combinations that are suitable for development of adequate glue bonds in white oak when bonded with certain resorcinol and phenol-resorcinol types of glues.

Materials and Procedure

Clear, flat-sawn white oak at about 12 per cent moisture content and of a specific gravity ranging from 0.65 to 0.80 based on volume and weight when ovendry, was used as test material. Six boards surfaced to ¾ inch by 6 inches were laminated into 4½- by 6-inch beams of various lengths. Each beam had an average density of at least 0.67.

The glues, given letter designations from A to E, were mixed about a half hour before they were spread. All gluing surfaces were double spread at the rate of about 60 to 65 pounds of glue per 1,000 square feet of joint area. The closed-assembly times were within the range recommended by the manufacturers of the glues used. Rocker-head or equalizing-pressure type retaining clamps, spaced 7 inches on center, were used to apply an average gluing pressure of about 200 pounds per square inch. Caul boards at least 2 inches thick were used both on top and bottom of the assemblies to aid in distributing the gluing pressure.

[1] Some of the work reported here was done in cooperation with the Bureau of Ships, Dept. of the Navy. However, the conclusions reached in this report do not necessarily reflect materials and techniques approved by the Bureau for use in Navy ships.

[2] Presented at the Northeast Section Meeting of the F.P.R.S., held October 30, 1957, in New York City.

[3] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

The Author: Magnus Selbo is Head of the Section of Glued Laminated Products at FPL. He holds a BS degree in chemical engineering from the Univ. of Washington. Selbo was formerly associated with the Associated Plywood Mills, Eugene, Ore., and Balfour, Guthrie & Co., Tacoma, Wash. A charter member of FPRS, Selbo is also a member of ACS and is a registered engineer in Wisconsin. Selbo was a Fulbright Research Scholar at the Norwegian Institute of Wood Technology, Oslo, Norway, during the academic year 1955-56.

Table 2.—RESULTS OF DELAMINATION TESTS[1] ON LAMINATED WHITE OAK BEAMS GLUED WITH GLUE B AND CURED FOR VARIOUS PERIODS AT 100°, 130°, 150°, AND 170° F. (GLUE-LINE TEMPERATURES)

Curing temperature °F.	Curing time Hours	Delamination Per cent
100	17	50.3
	161	26.7
	310	13.2
	478	6.8
130	1	30.5
	3	23.8
	5	16.0
510	1/2	19.8
	1	5.4
	2	3.7
	5	2.1
	10	1.4
710	1	1.6
	5	.9

[1]Conducted according to ASTM D1101–53, "Method for Testing the Integrity of Glue Joints in Laminated Wood Products for Exterior Service."

Table 3.—RESULTS OF DELAMINATION TESTS[1] ON LAMINATED WHITE OAK BEAMS GLUED WITH GLUE C AND CURED FOR VARIOUS PERIODS AT 80°, 100°, 110°, 130° AND 150° F. (GLUE-LINE TEMPERATURES)

Curing temperature °F.	Curing time Hours	Delamination Per cent
80	72	57.4
	336	8.7
	1,008	6.7
	2,016	3.8
	4,032	4.8
100	22	13.1
	214	5.0
	358	4.7
	526	1.0
110	1	33.6
	4	16.6
	9	7.7
	15	6.2
	20	6.9
	24	5.4
130	1	17.1
	3	3.9
	5	2.8
150	1/12	4.6
	1/2	3.9
	1	2.6
	3	2.3

[1]Conducted according to ASTM D1101–53, "Method for Testing the Integrity of Glue Joints in Laminated Wood Products for Exterior Service."

Table 4.—RESULTS OF DELAMINATION TESTS[1] ON LAMINATED WHITE OAK BEAMS GLUED WITH GLUE D AND CURED FOR VARIOUS PERIODS AT 100°, 130°, 150°, AND 170° F. (GLUE-LINE TEMPERATURES)

Curing temperature °F.	Curing time Hours	Delamination Per cent
100	17	36.2
	161	16.2
	310	6.1
	478	4.8
130	1/12	9.4
	2	6.3
	5	9.8
	10	6.3
150	1/12	6.3
	1/2	5.8
	1	4.2
	3	4.2
170	1/12	7.3
	1/2	4.5
	2	4.1

[1]Conducted according to ASTM D1101–53, "Method for Testing the Integrity of Glue Joints in Laminated Wood Products for Exterior Service."

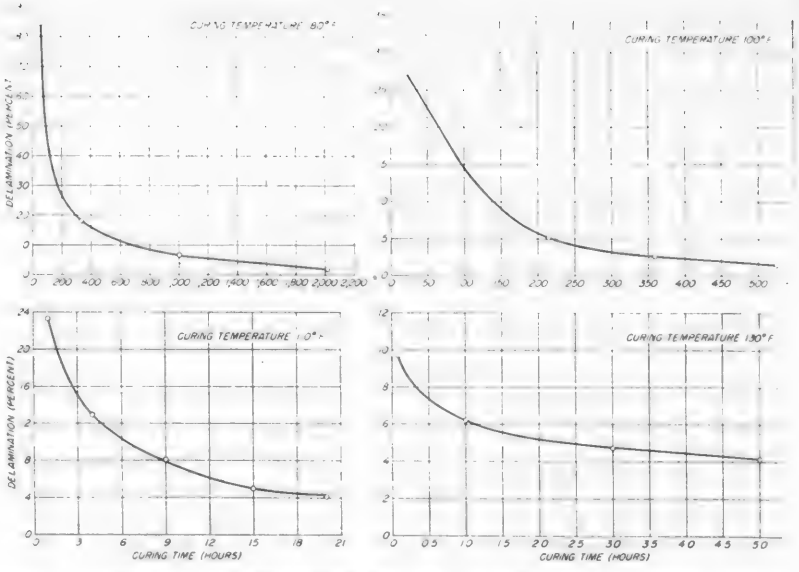


Fig. 1.—Changes in glue bond quality with curing time for glue A, a phenol-resorcinol, cured at four different temperatures (data in Table 1).

Two of the glues, A and B, were of the phenol-resorcinol type, and the others, C, D, and E, were resorcinols.

During the curing, the relative humidity was controlled to maintain a moisture content of about 12 per cent in the test beams. When the curing was done at temperatures above 100° F., the curing chamber was operated at 10° above the specified curing temperature until the temperature at the innermost glue line was about 5° below the specified curing temperature. At this time, the temperature in the chamber was reduced to the specified curing temperature until the various beams had been cured for the period assigned.

After the beams had been removed from the curing chamber, they were unclamped, and a 3-inch section was trimmed from one end and discarded. Two 3-inch sections for each curing period at 130° F. or higher were subjected to the cyclic delamination test (ASTM D1101–53). The first section was tested as soon as practical (usually from 1 to 3 days) after the beams were cured, and the second section was tested after a week or more of conditioning in a room at 80° F. and 65 per cent relative humidity. One 3-inch de-

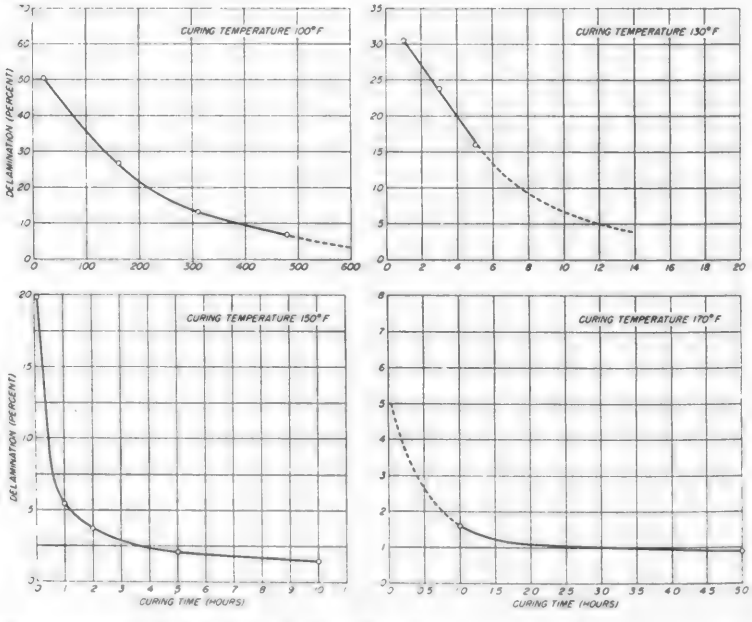


Fig. 2.—Changes in glue bond quality with curing time for glue B, a phenol-resorcinol, cured at four different temperatures (data in Table 2).

Table 5.—RESULTS OF DELAMINATION TESTS[1] ON LAMINATED WHITE OAK BEAMS GLUED WITH GLUE E AND CURED FOR VARIOUS PERIODS AT 80° 100°, 110°, 130°, AND 150° F. (GLUE-LINE TEMPERATURES)

Curing temperature °F.	Curing time Hours	Delamination Per cent
0	72	33.5
	336	9.2
	1,008	5.6
	2,016	5.1
	4,032	1.9
0	22	32.9
	214	6.7
	358	5.1
	526	3.8
0	1	32.0
	4	17.0
	9	13.8
	13	12.3
	20	12.2
	24	7.6
1.0	1/12	7.5
	2	5.3
	5	1.6
	10	3.4
1.0	1/12	1.3
	1	.7
	3	1.5
	5	1.1

[1]Conducted according to ASTM D1101–53, "Method for Testing the Integrity of Glue Joints in Laminated Wood Products for Exterior Service."

lamination section was tested for each curing period at 110° F. or lower. When possible, these sections were tested immediately after they had been cured for the specified time; otherwise, they were held at about 35° F. until they could be tested.

At curing temperatures above 110° F., one short beam, 12 to 14 inches in length, was glued for each curing period. In the beginning of the investigation, these beams were matched on the basis of density only, but the results were nevertheless somewhat erratic in that an increase in curing time did not consistently produce a decrease in the amount of delamination, as would be expected. Later, end-matched material was used for the different curing periods at each temperature with each glue, and more consistent results were obtained.

At temperatures of 110° F. and lower, a beam about 50 inches in length was glued, and then sections were cut off for tests after various periods of curing. The clamps and cauls were removed after an overnight cure at 80° F. and after completion of the shortest curing period when the curing temperatures were 100° or 110° F.

At the maximum curing temperatures used for the different glues, 150° and 170° F., the beams cured for the shortest period were heated until the center glue line reached the specified temperature, after which the supply of heat was discontinued. The temperature in the beams, of course, rose and dropped rather slowly, and although the heating at the maximum temperature was rather brief, there were extended periods of heating at lower temperatures. U.S.D.A. Technical Bulletin No. 1069 contains a graph illustrating this phenomenon.[4]

Results of Tests

The results of these tests are shown in Tables 1 through 5. As indicated previously, each delamination value listed under the cures at 80°, 100°, and 110° F. represents results from one test section, while each of the delamination values at 130°, 150°, and 170° F. is the average of results from two test sections. Some of the data shown in Tables 1 through 5 were plotted to show how the delamination (in per cent) varied with the curing time (in hours) at the various curing temperatures (Figs. 1, 2, and 3). These curves also illustrate the rates of cure for the glues at the different temperatures. When even the shortest curing time used at the highest temperature resulted in less than 5 per cent delamination, the graph for that temperature usually was omitted.

Sometimes the curve relating delamination to curing time did not cross the 5 per cent level of delamination. In this case, the curve was extrapolated to estimate the curing time required to produce delamination to the extent of 5 per cent. In general, this would not be justifiable if merely a single curve as in Fig. 2, the 170° F. cure, was considered by itself. It appears reasonable, however, if the data of the entire study are considered, since the amount of delaminations decreases with an increase in the curing time, and increases with a decrease in curing time at the different temperatures.

The delamination level of 5 per cent or less, after testing according to ASTM D1101–53, was set as a criterion to indicate whether a glue bond was adequately cured. The time corresponding to the level of 5 per cent delamination on the curves relating delamination to curing time (Figs. 1, 2, and 3) was used to indicate the minimum adequate curing period at various temperatures for the different glues. These curing times, taken from the curves in Figs. 1, 2, and 3, are listed in Table 6. For two of the glues, B and D, no acceptable delamination values of 5 per cent or less were obtained when they were cured at 80° F.

[4] U.S.D.A. Technical Bulletin No. 1069, Fabrication and design of glued laminated wood structural members, Feb. 1954, p. 73.

Table 6.—APPROXIMATE MINIMUM ADEQUATE CURING PERIOD[1] AT VARIOUS TEMPERATURES FOR FIVE RESORCINOL AND PHENOL-RESORCINOL GLUES ON LAMINATED WHITE OAK BEAMS

Curing temperature °F.	Curing time required				
	Glue A Hours	Glue B Hours	Glue C Hours	Glue D Hours	Glue E Hours
80	1,325	----	1,900	----	1,150
100	220	533	255	390	315
110	15.0	----	30.0	----	34
130	2.4	12	2.6	11.1	2.5
150	.1	1.2	.1	.7	.1
170		.1		.2	

[1]The curing periods for the different temperatures were taken from the curves relating curing time to delamination (samples in Figs. 1, 2, and 3) and are the values where these curves cross the 5 per cent delamination level.

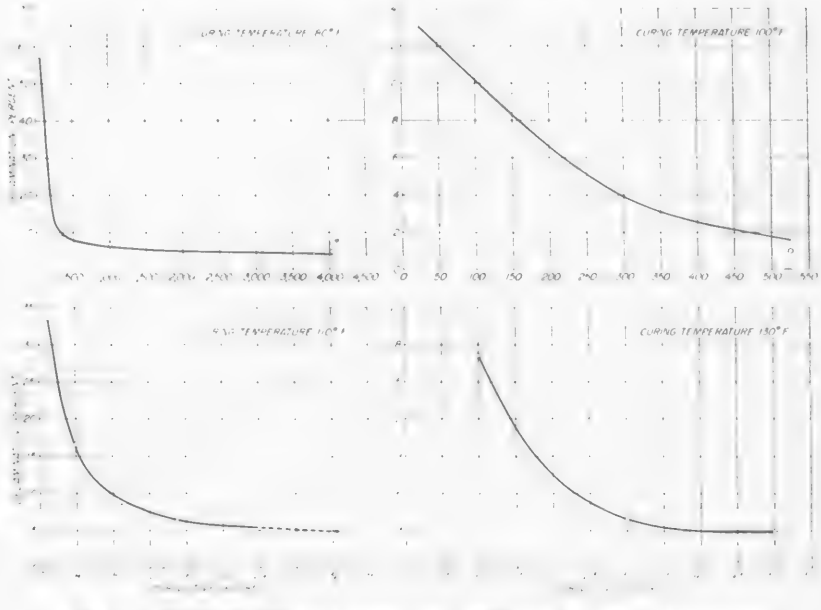


Fig. 3.—Changes in glue bond quality with curing time for glue C, a resorcinol, cured at four different temperatures (data in Table 3).

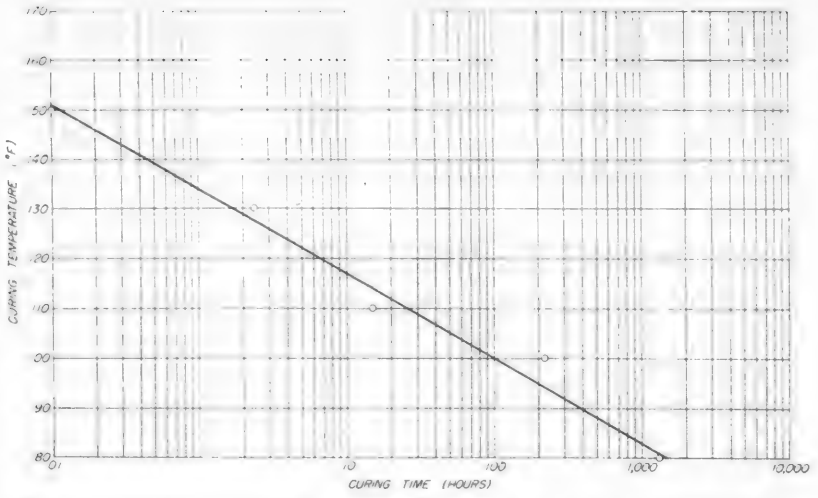


Fig. 4.—Curing times required at different temperatures for glue A, a phenol-resorcinol, when used on white oak (data in Table 6).

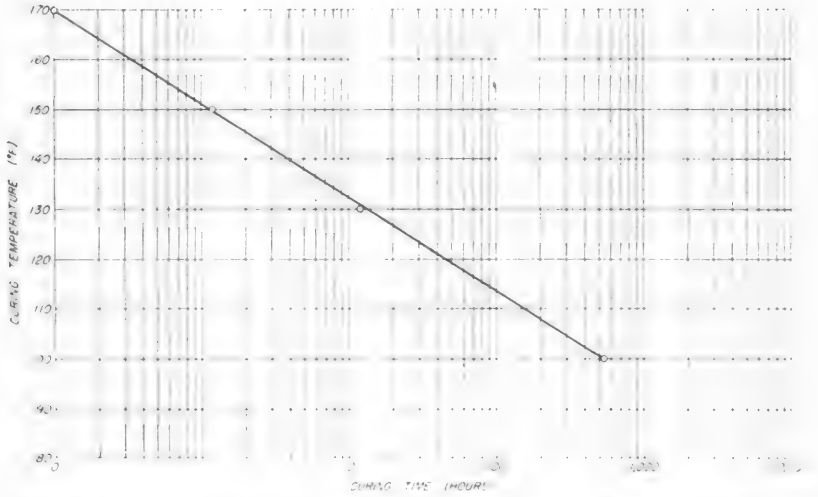


Fig. 5.—Curing times required at different temperatures for glue B, a phenol-resorcinol, when used on white oak (data in Table 6).

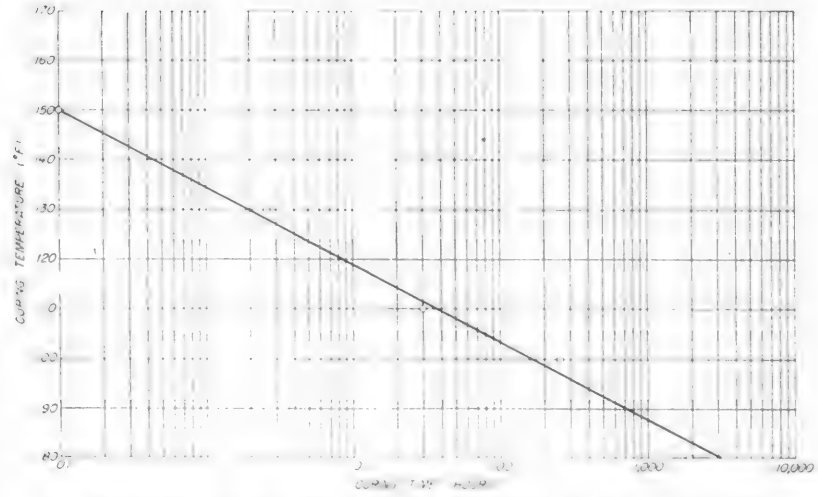


Fig. 6. —Curing times required at different temperatures for glue C, a resorcinol, when used on white oak (data in Table 6).

Some of the data in Table 6 were plotted on semilogarithmic paper (Figs. 4, 5, and 6) and show how the curing time varies with the curing temperature. The data on glue D were similar to those on glue B, and therefore were not plotted. Neither were the data on glue E plotted, because the performance was similar to that of A and C. Fig. 7 presents a general summary of the curing requirements of all the glues. Since some of the glues used required somewhat similar curing schedules, glues A, C, and E are represented by one line in Fig. 7, and glues B and D are represented by a second line.

Discussion of Results

The data are presented in Tables through 6 and Figs. 1 through 7. The different curves in Figs. 1, 2, and 3 are not directly comparable, since different scales have been used to best present the data available in each case. The graphs in Figs. 4, 5, and 6 indicate that, when the curing temperature for these glues decreased, the curing time increased exponentially. No curing temperatures lower than 80° were tried with oak, and two of the glues used did not meet the delamination limit of 5 per cent when cured from 12 to 24 weeks at this temperature. The same two glues, B and D, required a higher maximum curing temperature (170° F.) when cured for the minimum feasible time than did the other glues included in this investigation. For these glues, B and D, the curing temperature was raised until the temperature at the center of the beam was 170° F., and then the heat was shut off. Three glues, A, C, and E, showed about the same time-temperature curing requirements, although two of them made by the same manufacturer reportedly differed considerably in resorcinol content.

The fact that several glues exhibited similar time-temperature curing characteristics (Fig. 7) is rather significant because it permits grouping of glues with the same curing requirements and thus specifications can be simplified. The fact that there is a definite improvement in glue-bond quality for periods of several weeks to several months with some glues when the curing is carried out at 80° F. may also be of considerable practical importance. It opens up the possibility that straight stock, even of the denser species, can be glued and cured at room temperatures if the glued assemblies are protected from appreciable shrinking and swelling stresses while the glue bonds are still weak. Considerable care is necessary when curing dense species at room-temperatures to avoid

shrinkage stresses in the wood while the glue is curing.

The time-temperature curing curves shown in Fig. 7 are based on tests with clear, white oak lumber of slightly above-average density, and glued under laboratory controlled conditions. For production purposes, curing schedules with a certain margin of safety are suggested. In Fig. 8, the two different time-temperature curves shown have been designated Schedules I and II. Schedule I is the lower curve in Fig. 7 (representing glues A, C, and E) except that it has been moved up about 20° on the chart to give about a 2-hour margin of safety at 150° F. Schedule II corresponds to the upper curve in Fig. 7, except that it, too, has been moved up about 20 degrees and has been made parallel to Schedule I for simplification.

These schedules permit a wide selection in time-temperature combinations that can be used in curing laminated assemblies. For assemblies of small sections that can be heated rapidly, a relatively high temperature and short curing time may be most practical. With large sections, however, a longer curing time at a lower temperature might be the more economical way of curing.

The formulas in Appendix I show how curing times can be determined for different temperatures if two points on the time-temperature curve similar to those in Fig. 6 are available.

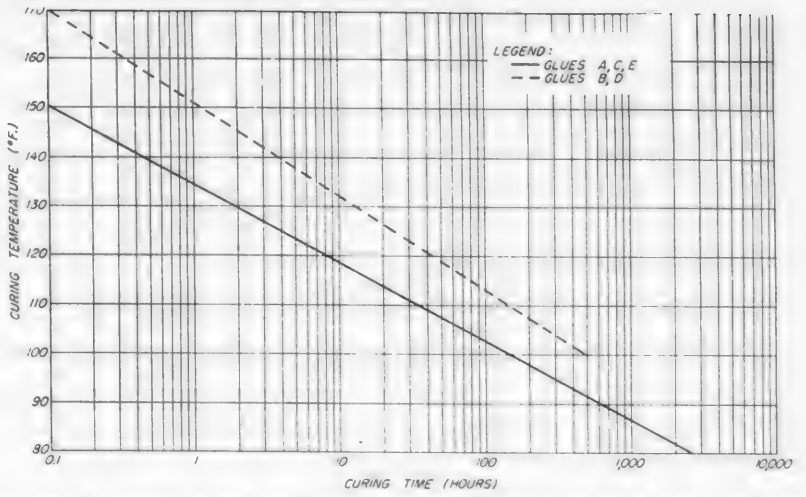


Fig. 7.—Minimum curing times required at different temperatures for five resorcinol and phenol-resorcinol glues on white oak. Glues A and B were phenol-resorcinols, while glues C, D, and E were resorcinols.

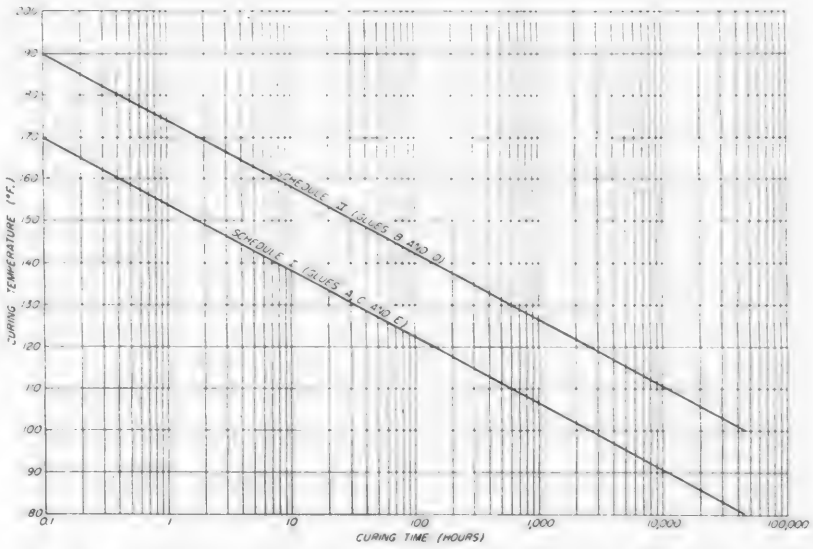


Fig. 8.—Recommended curing times at different temperatures for five resorcinol and phenol-resorcinol glues on white oak.

Appendix I

If x denotes curing time in hours and y denotes curing temperatures in °F., then

$$x = A10^{\frac{y}{B}} \qquad (1)$$

or

$$\log x = \log A + \frac{y}{B} \cdot 1 \qquad (2)$$

Let two known points on time-temperature curve be:

$x_1 = 10$ $\quad y_1 = 109$

and

$x_2 = 4$ $\quad y_2 = 117.4$

substituting in (2),

$$1.000 = \log A + \frac{109}{B}$$

$$.6021 = \log A + \frac{117.4}{B}$$

$$.3979 = -\frac{8.4}{B}$$

$$.3979B = -8.4$$

$$B = -21.11$$

also

$$1.000 = \log A - \frac{109}{21.11}$$

$$-\log A = -6.1634$$

$$\log A = +6.1634$$

$$A = 1.457 \times 10^6$$

Using these constants and given $y_3 = 90$,

$$\log x = 6.1634 - \frac{90}{21.11}$$

$$\log x = 1.900$$

$$x = 79.43$$

The Separation and Properties of Hemicellulose, Cellulose, and Hydrogenated Lignin from Sawdust[1]

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Most of the hemicellulose may be separated from hardwood sawdust by a brief alkaline extraction. The residual wood meal can be pulped in a soda cook with less alkali than is customarily used because most of the soluble carbohydrates have been removed. If pulping and catalytic hydrogenation are carried out simultaneously, the lignin is isolated in the form of distillable phenols and thermoplastic phenolic resins.

IDEALLY, WHEN A CHEMIST LOOKS at a mixture like wood, he attempts to separate it into individual chemical components with homogeneous properties. If he were able to do this with wood, he would isolate the cellulose alone, use it for derivatives and dissolving pulp; isolate the hemicellulose and use it as a source of polysaccharide material, perhaps to replace starch and gums in paper-making processes; isolate lignin and use it as a phenolic resin or multifunctional unit in a thermosetting resin.

Instead of that, consider a typical preparation of dissolving pulp today (Fig. 1). Wood is prehydrolyzed with water to degrade the hemicelluloses. The liquors are removed for evaporation and burning. The residue is pulped by a kraft process to give a crude pulp and an aqueous liquor containing lignin and carbohydrate degradation products. The crude pulp is bleached to desired purity to give a dissolving pulp, and the residues from the aqueous liquor are burned.

It is possible in some cases, however, to substitute other procedures for the first two steps in this process, and to obtain markedly different products from those which are now obtained, and in fact to approximate the ideal separation described above.

Hemicelluloses have long been known as the alkali-soluble polysaccharides of wood meal, but the best conditions for their extraction have not been well defined in the past. In principle, it should be possible to extract them with alkalis from wood meal instead of degrading them first with acid. The following figures show the effects of the pertinent variables on the extraction.

Fig. 2 shows how the rate of extraction of pentosan from birchwood depends on alkali concentration at 80°. Actually, it can be seen that it is the amount of pentosan available for extraction which depends strongly on the alkali concentration, and that the rate is little affected. At all alkali concentrations there is an extremely r pid leaching of available pentosans, ollowed by a very slow diffusion th re-after. Essentially all the pentosan hat is extractable under any given se of conditions is extracted quite rap dly and a lengthy extraction period is not particularly necessary[2]. This seems not to have been generally recognize in the past, for 4-hour extraction pe ods are not uncommon in the literatu

As might be expected, however, his very rapid extraction occurs only ith small particle size wood meal. The lif-ference in the extraction of white b rch chips and sawdust with 12 per ent alkali is indicated in Fig. 3[3]. Fo a rapid pre-extraction of the pentosan from wood it is therefore apparent hat small particle size wood meal is neces-sary.

Fig. 4 shows the residual pentosan left in birchwood meal after 24 hours of extraction with different alkali concentrations and at different temperatures. Very similar curves would be

[1] Presented at Session VIII, Chemical Utilization (Lignin), of the Eleventh National Meeting of the FPRS, held June 23-28, 1957, in Buffalo, New York. The paper is based on theses by H. G. Arlt, Jr., Russell Nelson, and Igor Sobolev presented for the PhD degree at the State University College of Forestry at Syracuse University. The work was largely supported by the U. S. Army Office of Ordnance Research, with related work supported by TAPPI.

[2] Nelson, R., and C. Schuerch 1956. J. Polymer Sci. 22, 435.

[3] Nelson, R., and C. Schuerch 1957. TAPPI, 40, 419.

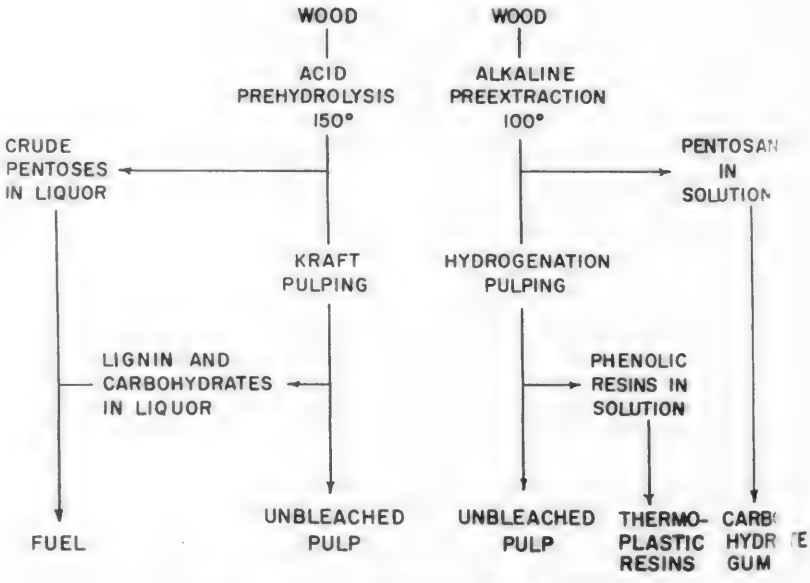


Fig. 1.—Present and proposed pulping methods.

The Author: Conrad Schuerch holds BS and PhD degrees in organic chemistry from Massachusetts Institute of Technology. He was sessional lecturer at McGill University, Montreal, from 1947 to 1949, where he received the first Hibbert Memorial Fellowship. He has been on the staff of the New York State College of Forestry since 1949.

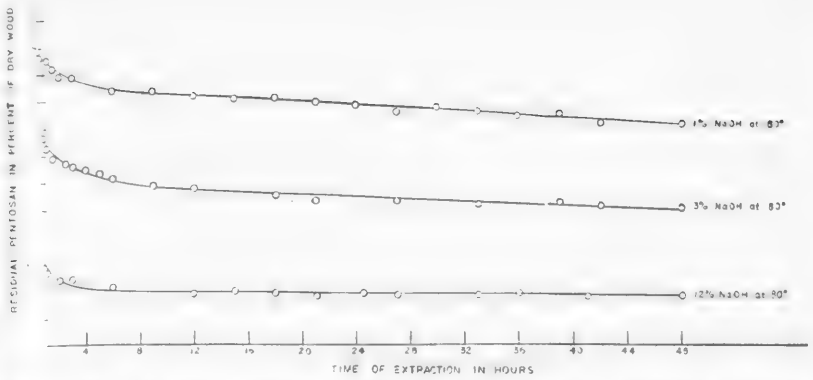


Fig. 2.—Effect of sodium hydroxide concentration on the rate of extraction of pentosan from 20–40 mesh birch wood meal at 80°.

obtained after one hour of extraction[2]. Each individual point on these curves represents a separate extraction of wood meal with alkali at a given temperature, and at a given alkali concentration. There is an interesting reversal of trend here, which shows that, if one treats wood meal at 20° with sodium hydroxide of concentrations above about 12 per cent, he actually extracts less pentosan than he would if he had used 4 per cent alkali. The point which is important, however, is first that the optimum condition of pentosan extraction is roughly 12 per cent alkali at 80°. Secondly, by decreasing the alkali concentration to about 6 per cent and maintaining a high temperature, one doesn't lose very much in efficiency of extraction. Only a small additional amount of pentosan is left behind. For practical purposes, a pre-extraction of birchwood sawdust can be carried out in the range of 6 to 7 per cent alkali, and almost as much pentosan is removed as at higher alkali concentrations.

The previous data were all obtained on birchwood, and it is important to note that different plant species behave differently on extraction with alkali[3]. Sugar maple wood meal (Fig. 5) behaves similarly to birch. The pattern of these curves at low temperatures follows those of birchwood meal so closely that undoubtedly at 80° a large percentage of the pentosan is extractable. Corncobs have a somewhat similar pattern, except that there is a high temperature dependence in the low alkali concentration range, which is not observed with the hardwoods. The yields of pentosan are quite good on extraction with 6 to 12 per cent alkali.

Bamboo, another grass, has the same general shape of curve as the corncobs but the amount extractable under these mild conditions is rather slight.

In sitka spruce, a softwood, not only is the pentosan content so low that pre-extraction is not particularly useful, but also very little comes out prior to delignification (Fig. 6). It appears probable that this kind of pre-extraction would therefore be useful only on hardwood of small particle size or grasses.

Table 1 lists some of the properties of pentosans extracted directly from birchwood meal and precipitated from aqueous solution by acidified acetone.[3] The pentosan content of the product as

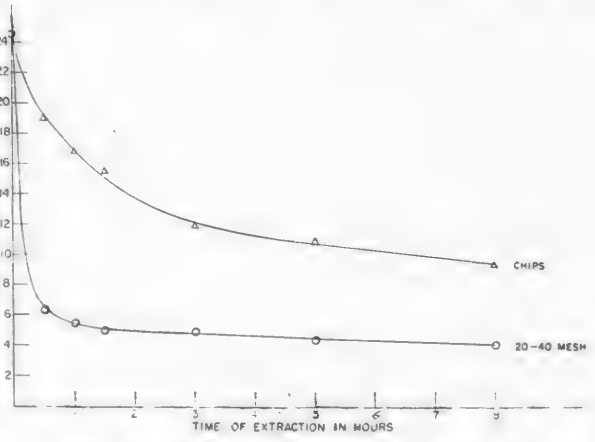


Fig. 3.—Rate of extraction of pentosans from white birch chips and sawdust.

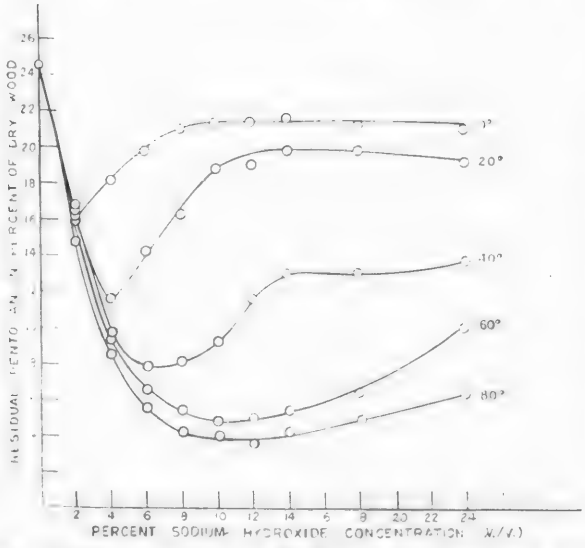


Fig. 4.—Pentosan remaining in 40–60 mesh birch wood meal after 24-hour extraction with sodium hydroxide.

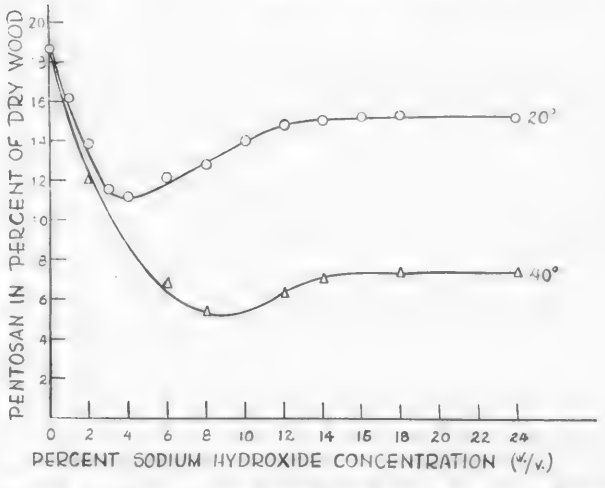


Fig. 5.—Residual pentosan in sugar maple wood meal after 24-hour extraction with alkali.

Table 1.—ANALYSES OF WOOD AND HEMICELLULOSE FRACTIONS

Sample	Conditions	Ash %	Lignin %	Apparent Pentosan %	10% KOH [α]D 25°	[α]D 25°	Recovery of Pentosan %
Hemicellulose from birch wood	12% NaOH 1 Hr., 100°	3.56	1.3	92.5	0.81	−85	62
Hemicellulose from birch holocellulose	6% NaOH 1 Hr., 30°	16.8	0.5	78.5	0.82	−59	78-82
Hemicellulose from maple wood[1]	20% NaOH 2 Hr., 67° 3% NaOH 2 Hr., 67°	7.1	0.0	93.3			48
Birch wood meal		0.02	18.7	24.6			
Birch holocellulose		9.3	0.96	28.6			
Maple wood meal		0.2	21.6	28.3			

[1] Rogers, S. C., R. L. Mitchell, and G. Ritter, 1947 J. Anal Chem., 19, 1029.

determined by the standard hydrochloric acid distillation is over 90 per cent. The intrinsic viscosity of the pentosan is as high as that of one obtained from birch holocellulose at low temperature. The high purity is indicated by the high negative rotation, for −90° is the highest value usually obtained for these pentosans.

Although the recovery was 62 per cent of the pentosan, actually the amount extracted under these conditions is about 85 per cent of the pentosan in the wood. Some of the more soluble fractions are lost in isolation. If one separates the pentosan in a stepwise fashion, increasing the alkali concentration, the first fractions contain most of the lignin impurity and the later fractions are isolated as an almost white powder. Pre-extraction of soluble lignin with very weak alkali is therefore one way to permit the isolation of the xylan largely free of lignin.

The precipitated xylan is amorphous and much more soluble than in the native state. It can be redissolved in hot water or cold 1 per cent sodium hydroxide. Furthermore, hemicelluloses are separated from alkaline steeping liquors in the viscose process by dialysis. These observations suggest that the xylan may be separated from alkali by dialysis while hot, and the alkaline liquors may be recirculated to extract fresh wood.

The second step in a typical preparation of dissolving pulp is the pulping of the prehydrolzed wood residue to give an unbleached pulp. It is of interest to know whether that can also be replaced by some method which would give a better lignin product than those commercial lignins now available.

A number of years ago, Pepper and Hibbert[4] described an experimental delignification that they used to study the structure of lignin (table 2). They showed that the hydrogenation of wood meal in the presence of alkali could produce a lignin-free pulp in 25 to 50 per cent yield, depending on the time of cooking. The pulp was isolated either mixed with catalyst or freed from the catalyst by acid washes, and apparently was not investigated further. Two per cent of the wood appeared as methanol; a quarter or more of the lignin appeared as three distillable phenols and the remainder as a chloroform–soluble alkali-soluble resin, which the authors pointed out had a rather low molecular weight since on further hydrogenation and hydrogenolysis they obtained 66 per cent of the lignin as distillable hydrocarbons and alcohols (Table 3).

Table 2.—CONDITIONS OF ALKALINE HYDROGENATION[1]

	Maple weight ratio	Aspen+straw weight ratio
Wood meal	1	1
Dioxane : Water 1:1	12	9
Raney nickel weight	0.7	.7
NaOH (in 3% conc.)	.33	.33

Initial hydrogen pressure 3000 lbs.

[1] Pepper, J. M., and H. Hibbert, 1948. J. Am. Chem. Soc., 70, 67. Pepper, J. M., C. J. Brounstein, and D. A. Shearer, 1951. ibid., 73, 3316.

There are also some additional interesting features to this reaction that the authors did not mention[5]. The total lignin fraction obtained on acidification is a viscous phenolic oil. When the monomers are removed from this oil, the non-distillable fraction, which amounts to about 60 per cent of the lignin, is a thermoplastic resin and melts to a clear brown liquid over a temperature range of 90 to 150°. Even if fractionated, the highest melting portions of the resin melt below 150°. The ether-insoluble portion of the resin has been tested for water pick up, and at 50 per cent relative humidity only absorbs about half the moisture absorbed by an ordinary commercial kraft lignin. It would appear that this resin is potentially a much more useful product than ordinary alkali and kraft lignins, and it might well be tested as a component of molding powders in place of phenolic novalacs. Since there are many hydroxyl groups per molecule in the resin, other methods of polymerization are also possible.

The conditions used by Pepper, Hibbert, and co-workers were not those which could be used for a commercial pulping process. But the shortcomings of their process are easily overcome[5]. Dioxane, which they used as a solvent, is not necessary and not

[4] Pepper, J. M., and H. Hibbert 1948. J. Am. Chem. Soc. 70, 67. Compare the related work of J. M. Pepper, C. J. Brounstein, and D. A. Shearer; ibid, 73, 3316 (1951) and H. G. Arlt, Jr., S. K. Gross, and C. Schuerch, TAPPI, in press.

[5] Sobolev, I., H. G. Arlt, Jr., and C. Schuerch. 1957. Ind. Eng. Chem. 49, 1399

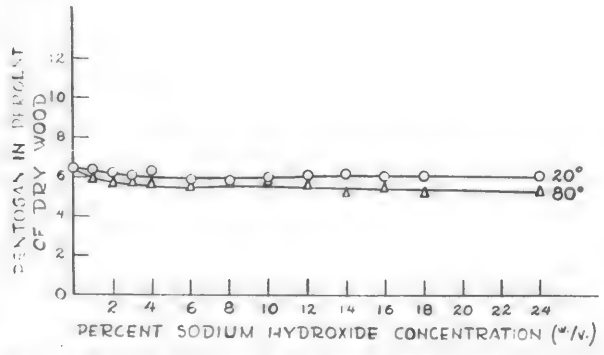
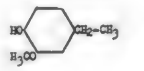
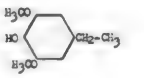
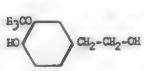


Fig. 6.—Residual pentosan in Sitka spruce wood meal after 24-hour extraction with alkali.

Table 3.—PRODUCTS FROM THE ALKALINE HYDROGENATION OF WOOD[1]

Product	Yield, per cent of wood: Maple, 6 hour cook	Aspen, 2-3 hour cook
Pulp (lignin free)	26	51
Chloroform-soluble resin (lignin) from which was obtained	21	13
	.46	
	3.23	
	1.3	
Methanol	2	2.3

[1] Pepper, J. M., and H. Hibbert, 1948, J. Am. Chem. Soc; 70, 67. Pepper, J. M., C. J. Brounstein, and D. A. Shearer, 1951, ibid., 73, 3316.

Table 4.—TYPICAL PULPS FROM ALKALINE HYDROGENATION

% NaOH 165° C.	Yield	Lignin	α	Pentosan	Degree of polymerization	$KMnO_4$ No.
White birch chips[a]	46.3	2.2	83.7	22.5	1248	11.6
Sugar maple meal[b] c.	45.	1.25	90.0	11.7	1965	----
Norway spruce chips[a]	54.5	20.0	74.3	-----	----	27.7
White pine chips[a]	49.0	16.8	----	-----	----	26.0
5% NaOH 180+5°C						
Sugar maple meal[b]	30	0.06	86	1.8	340	(Br. 72)
Sitka spruce meal[b]	34	0.03	89	0.78	457	---
3% NaOH 180°C						
Sitka spruce meal[b]	36	1.25	92	4.3	664	----
5% NaOH 168°C						
White birch chips[a]	40	0.96	93.3	10.6	700	5.1
7% NaOH 165°C						
White oak chips[a]	37.4	0.02	90	6.3	765	7.8

Conditions: Initial hydrogen pressure 400–600 p.s.i.; one hour heating to temperature, three hours at temperature, rapid cooling. Liquor to wood ratio 10:1 or 20:1. Catalyst, ⅛-inch tableted nickel on kieselguhr Harshaw 0104T in separate screen container (labeled a) or Raney nickel mixed with pulp and separated magnetically (labeled b). Weight ratio of catalyst to wood 0.5 to 1.5.

Table 5.—COMPARISON OF SODA AND HYDROGENATED PULPS

	Yield	Lignin	Degree of polymerization
EXPERIMENTAL PULPS			
Hydrogenated pulps			
5.7% NaOH (initial conc.)	38+	1.03	966
8.3% NaOH (initial conc.)	36+	0.80	618
Soda pulps			
8.3% NaOH	40	1.21	648
COMMERCIAL SODA PULPS			
A (mixed hardwoods)	----	0.93	858
B (mixed hardwoods, modified soda with 18% can. sulfidity)	----	----	935
C (poplar)	----	1.30	968

Conditions: White birch chips (¾"), hydrogen pressure 400-600 p.s.i., one hour heating period, three hours at temperature of 165-168°C. Liquor to wood ratio 6-1. Raney nickel catalyst mixed with chips.

particularly useful. The same results are obtained in aqueous alkali. It is not necessary to contaminate the pulp with a catalyst. The catalyst can be retained in a separate chamber, and the dissolved wood components can be hydrogenated as the liquor passes through the chamber. The hydrogen pressure that they used is far greater than necessary. Initial hydrogen pressures as low as 300 to 600 pounds per square inch have given essentially the same results.

Liquor to wood and alkali to wood ratios typical of the soda process can be used. In the usual soda process, most of the alkali consumption is caused by carbohydrate degradation. Therefore, if pentosans are pre-extracted, substantially less alkali is needed in pulping. An investigation of sitka spruce, bagasse, white birch, norway spruce, white pine, Douglas-fir, and white oak indicates that, as expected, the pulping of softwoods is harder than that of hardwoods. Under conditions that yield a hardwood pulp with one or two per cent of lignin, a softwood still contains about 10 per cent of lignin.

Table 4 shows typical pulps obtained from a variety of wood species. As can be seen, some of these have been carried out at more drastic conditions than would be advisable in order to set the limits of the process[5]. Essentially, the results are about what can be expected from soda pulping. Table 5 shows a comparison of some hydrogenation pulps with commercial soda pulps. The results are very similar, and there is no change produced in the degree of polymerization or molecular size of the pulp by hydrogenation. The only difference in the pulps appears to be that, at a given degree of delignification, the color of the hydrogenated pulp is somewhat lighter.

Fig. 7 then summarizes this proposed experimental two-stage pulping process in detail:

Hardwood sawdust is pre-extracted, preferably in a countercurrent fashion, with 7 to 12 per cent sodium hydroxide at 80 to 100°. The alkaline liquors are separated and dialyzed while hot. The dialyzed liquors are reconcentrated and recirculated to extract fresh wood meal. The pentosans remain behind in aqueous or weakly basic solution. The residual wood meal is pulped under conditions that approximate a soda cook, but with less sodium hydroxide, and the liquors are circulated through a catalyst chamber containing a nickel catalyst and a hydrogen pressure of a few hundred pounds. The pulp and alkaline liquors are separated in the usual way, and the lignin fraction is separated from the liquors by carbon dioxide precipitation. Alkali recovery is as usual by concentration, burning, and causticization.

There are factors, of course, that together may prevent practical applications of such a process. Each of these steps is analogous to present industrial processes, however. The application of such a pulping method would permit the chemical utilization of an inexpensive wood source. It would result in the recovery of about 75 per cent of the wood as three major fractions with reasonably attractive physical properties, plus some methanol. This yield is about double that obtained in present-day production of dissolving pulp. It would appear that these advantages should justify a careful and complete evaluation of the proposal.

Discussion

J. B. Doughty (West Virginia Pulp and Paper Co.): How do the results of this work compare with the sodium hydroxide methanol work?

Dr. Schuerch: The reaction with lime and alcohol is of course not a pulping process. The higher temperatures used would almost certainly destroy the cellulosis fibers. It would have to be applied to an isolated lignin, and the results would depend on the kind of lignin used. We have not made this comparison, but it would seem very likely that soda or kraft lignin would probably give more complex mixtures of products than would hydrogenation pulping. We are certain that there is an advantage in pulping and hydrogenating simultaneously rather than hydrogenating the soda liquors.

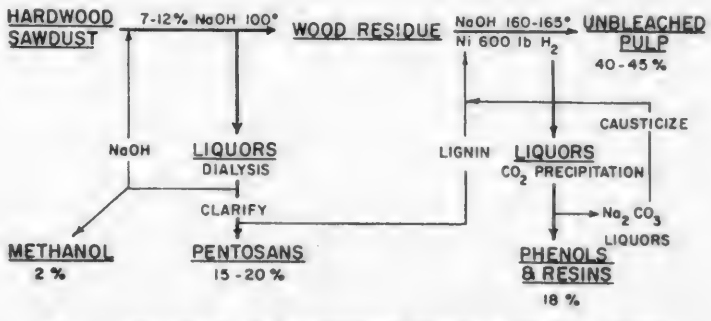


Fig. 7.—Pre-extraction and hydrogenation pulping of hardwood sawdust.

Power Requirements for Log Carriage Setworks[1]

MILTON H. MATER
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Basic engineering data are used in the derivation of a formula for the approximate power requirements for a log carriage setworks. Values of friction and efficiency are assumed on the basis of field experience. Examples show how to use the formulas in typical mill situations.

THE SETWORKS IS A GENERAL TERM referring to the mechanism which moves the log laterally toward the sawline before each saw cut is taken. Setworks vary from crude, hand-operated ratchets to highly complicated remote-controlled units with feedback systems. This paper is not concerned with the setworks controls, but with the power required to actually move the log. More particularly, it is an attempt to supply data for the design of setworks power units, either for the small operator who wishes to change his carriage setworks from a hand-operated one to a motorized one, or for the machine designer who wishes to have some formula on which to base his calculations.

The power requirements for a setworks depend on the following factors:

1. Weight of heaviest log sawn.
2. Weight of knees.
3. Friction between log and block, and between knee and block.
4. Speed at which set-out is to be made.
5. Efficiency of transmission from setshaft to knee.
6. Efficiency of transmission from power source to setshaft.
7. Speed at which recede is to be made.

The Weight of the Log: This weight must be the heaviest that the setworks will be required to move on the particular size of carriage for which the setworks is designed. Usually this will depend on carriage opening and length of log; for instance, in calculating a drive for a 42-inch opening carriage sawing logs for 16 foot lumber, the assumption would be made that a 4 foot diameter log 17 feet long would be the largest sawn. It is usually safe to assume that a log will not be loaded on the carriage if it is more than 6 inches greater in diameter than the carriage opening or 1 foot longer than the longest lumber in length. If the material were ponderosa pine weighing 45 pounds per cubic foot wet weight, then the weight of the log would be calculated by the following formula:

Weight $= \pi\ r^2 \times L \times w$, where $\pi = 3.1416$; r = radius in feet (one half the diameter of the log); L = length in feet; and w = weight per cubic foot.

Substituting the above data in the formula:

Weight $= 3.1416\ (2)^2 \times 17 \times 45 = 9620$ pounds.

The Weight of the Knees and Dogs: This weight varies with the type of carriage. In some types, 200 pounds might be the total weight of the knees and dogs; in others, the knees and dogs may weigh over 1000 pounds each. For purposes of example, assume that the knees and dogs weigh 500 pounds each. For a three-block carriage, the total weight would be 1500 pounds.

Friction Force between Log and Block: The friction force between log and block depends on weight of the log and the coefficient of friction, μ. This coefficient varies greatly with the types of surface that are in contact. A gritty bark on the log makes μ greater; a wet, debarked log makes μ smaller. The coefficients are usually determined by experiment, as they consist of many variables. It is the general practice to assign a high coefficient of friction (0.50) to logs with bark on them. The force required to overcome the friction between log and block during set-out is found by the formula:

$F = \mu W$, where W is the weight of the log.

In this example: $F = 0.50\ (9620) = 4805$ pounds.

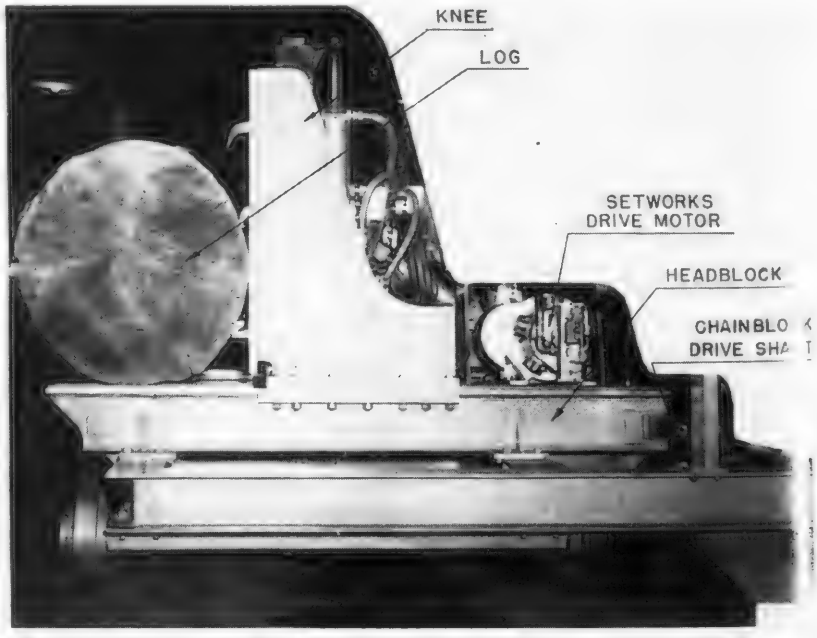

Fig. 1.—A Mater power setworks installation.

[1] Presented at Session X, Lumber Manufacturing, FPRS 11th National Meeting, June 23-28, in Buffalo, N. Y.

The Author: M. H. Mater is the head of Mater Engineering, sawmill consulting engineers, and president of Mater Machine Works, Inc., sawmill machinery manufacturers. A licensed mechanical engineer, Mater holds a BS in mechanical engineering, and has written about 50 papers on sawmill mechanization and automation.

Force required to overcome friction in moving the knees is calculated in a similar manner. However, since the knees have metal-to-metal contact and are usually lubricated, or at least wet, a friction factor of 0.25 is used. This is high for metal-to-metal contact and allows for grit and bark particles on the surfaces. In the example, then, if the knees weighed 500 pounds each, or 1500 pounds for three, the force required is:

Force $= \mu\ \omega$ where ω is the weight of the knees or
$F = 0.25\ (1500) = 375$ pounds.

The Speed at Which the Set-outs are to be Made: This speed is an important factor in determining the horsepower requirements of the drive. Ideally, the drive should accelerate the log from a stationary position to its full set-out speed in 1 inch; this permits the 1-inch settings to be made at a constant speed in the same manner as the other settings. If the setworks drive is still accelerating as it passes the 1 inch mark, the acceleration will vary with the weight of the log and thus cause erratic settings on one inch boards. The basic formula for determining the force required to accelerate a weight is:

$$F = \frac{W}{32.2}\,(a);$$ where W is the weight and 'a' is acceleration.

Assuming that a set-out speed of 20 feet per minute is required, then to reach this in one inch of movement, the acceleration must be:

$$a = \frac{v_t\ v_o^2}{2\ S};$$

where v_t = final velocity, 20 fpm;

v_o = initial velocity, zero; and

s = the distance, 1 inch, or 1/12 foot.

changing 20 ft/min. to ft/sec. $= \frac{20\ \text{ft/min}}{60\ \text{sec/min}} = \frac{1}{3}$ ft/sec

then, $a = \frac{(\frac{1}{3}\ \text{ft/sec.})^2}{2\ (1/12)'}$

$= \frac{2}{3}$ ft/sec^2

The force required to accelerate the knees, which weigh 1500 pounds, and the log which weighs 9620 pounds, from a stationary position to 20 feet per minute in one inch is:

$$F = \frac{1500 + 9620\ \text{pounds}}{32.2\ \text{ft/sec}^2}\ (.667\ \text{ft/sec}^2) = 238\ \text{pounds.}$$

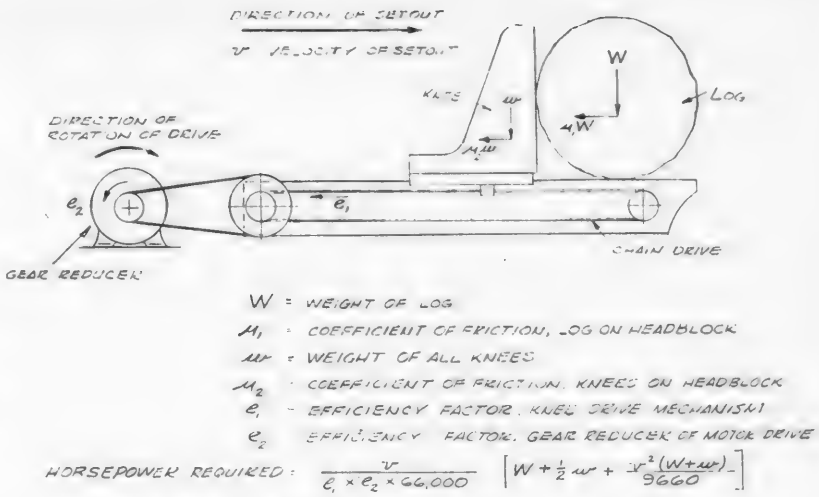
DIRECTION OF SETOUT
V VELOCITY OF SETOUT
KNEE
W
LOG
DIRECTION OF ROTATION OF DRIVE
GEAR REDUCER
CHAIN DRIVE
W = WEIGHT OF LOG
μ_1 = COEFFICIENT OF FRICTION, LOG ON HEADBLOCK
ω = WEIGHT OF ALL KNEES
μ_2 = COEFFICIENT OF FRICTION, KNEES ON HEADBLOCK
e_1 = EFFICIENCY FACTOR, KNEE DRIVE MECHANISM
e_2 = EFFICIENCY FACTOR, GEAR REDUCER OR MOTOR DRIVE
HORSEPOWER REQUIRED = $\frac{v}{e_1 \times e_2 \times 66{,}000}\left[W + \frac{1}{2}\omega + \frac{v^2(W+\omega)}{9660}\right]$

Fig. 2.—Forces involved in setworks drive power requirements.

The total force required to overcome friction and accelerate the log and knee to the required speed is: $4805 + 375 + 238 = F = 5418$ pounds

Efficiency of Transmission from Setshaft to Knee: Assuming that a chain or rack and pinion block is used, the friction loss in transmitting the force to the knee can be assumed to be about 10 per cent. This requires that another 542 pounds be added to the force required at the setshaft, or $F = 5960$ pounds. (If a screwblock were used, the friction loss would be assumed at 20 per cent) The horsepower requirement at the setshaft would be:

$$hp = \frac{\text{Force} \times \text{Velocity}}{550}$$

$$= \frac{5960 \times .33}{550} = 3.58\ \text{hp}$$

The Efficiency of Transmission from the Power Source to the Setshaft: This efficiency depends on the type of setworks drive that is used. If a start-stop drive, with a spur-geared reducer is coupled directly to an electric, air, or hydraulic motor, and if the reducer is sprocketed directly to the shaft, then a friction loss of only 5 or 10 percent can be assumed. At 10 per cent, the problem examined above this would only increase the requirements by .358 horsepower to a total of 3.94 horsepower. A 5 hp electric or air motor would be required.

If a worm-gear drive is used, the drop in efficiency is closer to 20 per cent, so the horsepower requirement would be $3.58 + (3.58 \times .20)$ or 4.30 hp. It should be noted that electric motors usually have a starting load potential of 125 per cent of rated horsepower. This means that a 3 horsepower motor could be used to start a load where 3.75 horsepower is required, without injury to the motor. But it is good practice when designing a setworks drive to ignore this overload factor, since heavier logs, unlubricated headblocks, extra amounts of grit and dirt on sliding and power transmitting contacts, and many other variables, may require the use of the overload capacity. Air motors have a similar capacity for overload, since they slow down without harm under excessive loading. Hydraulic systems, however, are governed to a maximum capacity by a relief valve of some type. This is usually a spring-loaded valve which by passes the oil when the load becomes excessive. It is therefore important to be sure that the hydraulic system will take care of overloading by using a next-size larger pump and other equipment. In a hydraulic system, a further efficiency drop of 10 to 20 per cent would have to be taken into consideration, so the electric motor drive for the hydraulic pump would be required to put forth $3.94 + (.20 \times 3.94)$ or 4.73 horsepower. In this case, a 5 hp electric motor would still be used.

When a continually running electric motor is used, an additional factor for the efficiency of transmission through the power transmitting system must be taken into consideration. When loose and tight belts are used, as in some older types of Trout setworks, the efficiency may be very low, while with modern clutch-brake systems the efficiency may be comparatively high. However, many accidental variables enter into the setworks drive problem: a belt may become oily or greasy, clutch linings will wear, open bevel gear trains may spread apart and reduce efficiency, and so forth. Usually

an additional 25 per cent efficiency loss is allowed for these variables. In the problem discussed above, assuming that a spur gear reducer and clutch-brake transmission is used, then the horsepower demand would be 4.93 horsepower. This is close to the borderline of a 5 hp motor rated capacity. In many cases it would advisable to use a 7½ hp electric motor for this drive; for instance, if this were a dry operation and the logs were very dirty, or if many very heavy logs, such as sinkers, were encountered, or if all dogging were of the hook or knight type where the pressure is exerted downward, and so forth, the greater horsepower would be used.

Speed at which Recede is to be Made: In some unusual cases where the knees are very heavy and the logs very light, and a high recede speed is required, the recede speed can theoretically govern the horsepower requirements of the setworks. This is so because speed is such an important factor in the horsepower requirements formula that doubling the speed in receding, for instance, will greatly increase the horse power required.

Power Requirements of Setworks

An approximate formula that may be used to determine the horsepower requirements of a setworks drive may be expressed as:

$$hp = \frac{v}{e_1 \times e_2 \times 66{,}000} \times \left[W + {}^{1/2}\omega + \frac{v^2 (W + \omega)}{9660} \right]$$

where: v = velocity (speed) of set out in feet per minute,
W = weight of heaviest log, in pounds,
ω = weight of all knees, in pounds,
e_1 = efficiency factor based on knee movement mechanism ($e_1 = 0.9$ on rack and pinion or chainblock headblocks, 0.8 on screw-blocks);
e_2 = efficiency factor based on the drive reduction and transmission
$e_2 = 0.9$ when a spur gear reducation is used. e_2 for belting takes a much lower value, based on the the number of belts used: for one belt it can be assumed to be 0.75; for two belts, 0.56.)

To illustrate the application of the formula, the following example is given:

Problem: A sawmill three-block log carriage opens to 42 inches. The air dog knees weigh 500 pounds each. Ponderosa pine logs weighing 45 pounds per cubic foot are sawn. The largest log loaded onto the carriage will be 48 inches in diameter and 17 feet long. Set-out speed required is 20 feet per minute. The carriage has chain headblocks and motor drive with a spur gear reducer sprocketed to the setshaft. What size should the motor be on a) an electric motor drive, b) an air motor drive, and c) a hydraulic drive.

Solution: The weight of the largest log is: $W = \pi r^2 L P$, where: r = radius.

$W = 3.1416\ (2)^2\ 17\ (45)$, (½ diameter) = 2 feet
$W = 9620$ pounds, L = length = 17 feet
P = pounds per cubic foot = 45

Substituting in Horsepower formula:

v = velocity = 20 feet/minute;
$W = 9620$;
$\omega = 3 \times 500$ pounds per knee = 1500; $e_1 = 0.9$; $e_2 = 0.9$

$$hp = \frac{20}{(.9)(.9)\ 66{,}000}\left[9620 + \frac{1500}{2} + \frac{(20)^2\ (9620\ 1500)}{9660}\right]$$

$$hp = .000374\ (10{,}830) = 4.05$$

Answer:

a) a 5 hp electric motor would be adequate.

b) *The Air Motor Setworks drives* are calculated in the same manner as electric motor drives. Air motor ratings are also low, and they have the additional facility of slowing down without injury when over-loaded, which an electric motor does not have.

c) *Hydraulic Setworks Drives* are calculated in a similar manner as the electric drives. However, since the hydraulic pumping unit is driven by an electric motor, the usual requirement is to find the size of the electric motor. The efficiency of a hydraulic pumping system may be taken as 80 to 85 per cent in a setworks drive, so the horsepower of the hydraulic motor should be divided by 0.8 to give the horsepower of the electric motor:

$$\frac{4.05\ \text{(from example above)}}{0.8} = 5.06$$

A 5 hp electric motor would be used on the hydraulic setworks system as well as in the others.

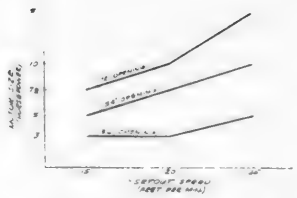

Fig. 3.—Typical curves of horsepower requirements against setout speed for different opening carriages.

Table I gives recommended drive motor sizes for setworks. These values should be used as guides in working out setworks drive problems, because they are valid only for the specific figures used in the calculations.

Table 1.—RATED HORSEPOWER OF ELECTRIC DRIVE MOTOR

Headblock opening	Setout speed a) 15 feet/min	b) 20 feet/min	c) 25 feet/min
36"	3	3	5
42"	3	5	5*
48"	5	5*	7½
54"	5*	7½	10
60"	7½	7½*	10
72"	7½*	10*	15

*If sinker logs may be encountered or gritty conditions on headblocks and bark, use next larger size motor.

Conditions Assumed in Table 1

1. The carriage is a three headblock carriage with rack and pinion or chain and sprocket movement mechanism.
2. A spur gear reducer is used with the electric motor.
3. Logs: a) weight—45 pounds per cubic foot, b) largest diameter—6 inches greater than carriage opening, c) longest length—17 feet
4. Three knee weights as follows: 36 inch opening—600 pounds, 42 inch opening—1000 pounds, 48 inch opening—1600 pounds, 54 inch opening—2400 pounds, 60 inch opening—3200 pounds, and 72 inch opening—4000 pounds
5. Velocity of Setout Required: a) 15 feet per min., b) 20 feet per min., c) 25 feet per min.

The Effect of Fungal Decay on the Benzidine Test for Distinguished Heartwood and Sapwood in Pine[1]

E. W. J. PHILLIPS and CYNTHIA A. SAVORY
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Experiments were carried out on Scots pine with four wood-rotting fungi to determine the limitations of the benzidine test. Substantial decay must occur before the heartwood fails to give some trace of the characteristic reaction. Sapwood treated with certain preservatives, including creosote, may give a benzidine reaction similar to that of heartwood.

THE INVESTIGATION OF CASES of premature decay in timber usually involves determining whether the rotted wood is sapwood, and therefore naturally more susceptible to fungal attack, or heartwood, which would signify that the wood had been exposed to exceptionally severe conditions or had contained traces of infection when put into use.

For dealing with pine timbers, the benzidine test, put forward by Koch & Krieg (1)[2] in 1938, is one of the most useful means of differentiating between sapwood and heartwood. This test requires two reagents, which may be prepared as follows (2). One reagent is made by dissolving 5 gm. of benzidine in 23 cc. of 25 per cent hydrochloric acid and 970 cc. of distilled water. (The 25 per cent acid can be conveniently prepared by taking 25 cc. of concentrated hydrochloric acid (38 per cent) and adding water to make up to 38 cc.). The other is prepared by dissolving 10 gm. of sodium nitrite in water to make 100 cc. of solution. Equal volumes of the two reagents are mixed just prior to testing. It is best to use the mixture when freshly prepared, although it remains reasonably effective for at least two or three days.[3]

The mixed solution is brushed on the planed or clear pared surface of the wood: heartwood quickly develops a bright red color while sapwood stains yellow or yellowish-brown. The colorations are more or less permanent, although they tend to tone down after prolonged exposure to light. The test depends on the presence of pinosylvin and allied substances in the heartwood, which react with the diazotised benzidine to give the red color (3). Pinosylvins, which are considered to give the heartwood its resistance to decay, are lacking in sapwood.

It should be noted that the benzidine test is believed to be applicable only to the pines, and does not work with other common softwoods such as spruce, larch, or Douglas-fir, nor with hardwoods.

In sound pine timber, it usually is possible to differentiate between sapwood and heartwood merely from the distinct difference in natural color between the two, but in freshly pre-

[1] Contributed as part of the program of the Forest Products Research Board. Publication is by permission of the Department of Scientific and Industrial Research.

[2] Numbers in parentheses refer to the Literature Cited at the end of this paper.

[3] Kohn and O'Kelly (5) have shown that ortho-tolidine can be used as an alternative to benzidine for blood tests, and the authors have found it to be a satisfactory substitute in the pine heartwood test; weight for weight substitution was used. Neither benzidine nor ortho-tolidine reagents should be allowed to come into contact with the skin, nor should the dust or vapor be inhaled.

The Authors: E. W. J. Phillips holds BSc and PhD degrees from London University. He joined the Wood Structure Section of the English Forest Products Research Laboratory in 1930. He has been concerned with tree physiology and wood anatomy in relation to timber properties and identification.

Mrs. Savory holds a BSc degree from the University of Bristol, and is a member of the Mycology Section of the Laboratory. She has worked on the toxicity of preservatives and on the staining fungi, especially those associated with tropical woods.

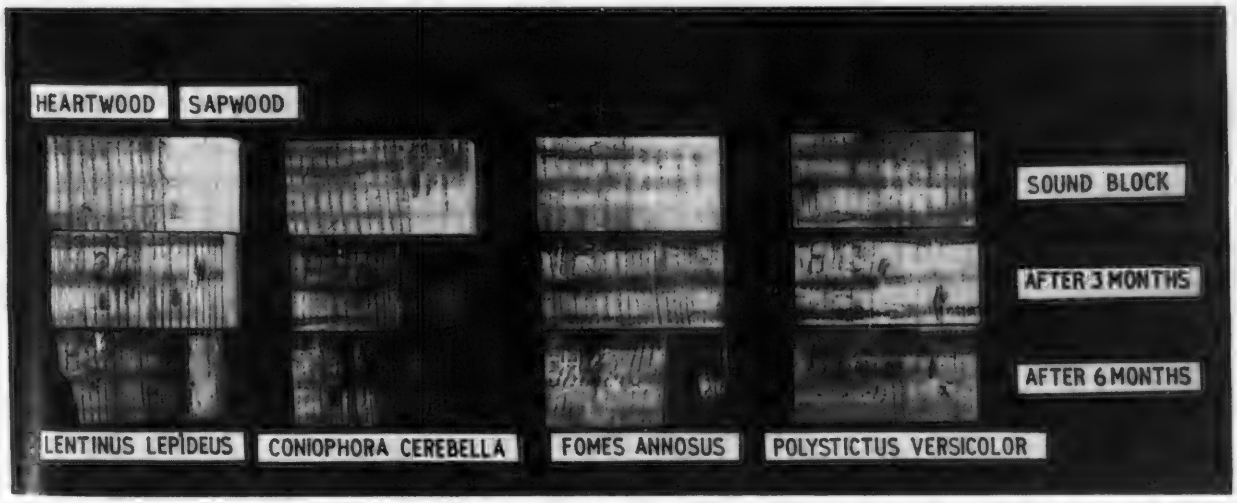

Fig. 1.—Representative test blocks. The horizontal streaks on each block are benzidine tests made at intervals during the investigation. The top streak on each block is the initial test, and in heartwood this remained visible even in rotted wood. The middle test streaks were made on the moist blocks after the period of exposure to the fungus, and the bottom streaks are repeat tests after the blocks had dried out. A red to slightly reddish-brown heartwood reaction was obtained even after 6 months of exposure, except with *Lentinus*. Characteristic shrinkage is noticeable in the *Coniophora* and *Lentinus* blocks. The streaks on the "sound block" or control specimens were made initially (top), at 3 months (middle), and at 6 months (bottom); similar reactions were obtained each time.

pared timber the color difference is commonly slight or entirely lacking. In such cases, even microscopic examination of the wood may fail to reveal any difference between sapwood and heartwood. Some indication may be obtained by a porosity test; water poured over an end-grain surface sinks in much more rapidly in the sapwood. If time permits, the timber may be exposed for a period to sunlight, or to ultraviolet light, and the heartwood will then develop its characteristic color. The benzidine test, however, will give a quicker and often more definite answer. In timber attacked by fungi, however, the natural color difference may be obscured, and it was uncertain to what extent the fungal activity would interfere with the benzidine reaction. For this reason, the following experiments were carried out. Home-grown Scots pine *(Pinus sylvestris)*—the same species that furnishes Baltic redwood—was selected for test, because this species of pine is the softwood most commonly used in the United Kingdom.

The Test Fungi

Four species of fungus were selected for the tests. All are known to have some degree of tolerance to the pinosylvins, and so are able to decay pine heartwood, although in most cases at a slower rate than sapwood. Two of the fungi, *Lentinus lepideus* and *Coniophora cerebella,* cause brown rots, that is, they bring about the breakdown of the cellulose portion of the cell walls without attacking the lignin to any appreciable extent. The other fungi, *Fomes annosus* and *Polystictus versicolor,* are of the white rot types, they possess polyphenol oxidase enzymes and are able to attack both lignin and cellulose. Further details of the character and behaviour of these four species are given below.

Fommes annosus: This fungus is by far the most important cause of heart rot in conifers in this country. It occurs most frequently in larch, spruce, and Douglas-fir. It probably gains access to the heartwood through dead or diseased roots, and the first symptom of attack is a reddish coloration that extends upward in streaks from the butt. Later, small white pockets of rot develop, and after the tree has been felled, decay continues slowly.

Polystictus versicolor: This fungus produces a white rot in hardwoods, and occasionally attacks softwoods. It is usually found on felled timber, but has been known to cause a heart rot in standing trees of *Catalpa speciosa.* Although not commonly found on softwoods, it was included in these experiments as being one of the most active white-rot fungi.

Lentinus lepideus: The heartwood of a number of species of pine is attacked by this fungus, which enters the standing tree through wounds; it is frequently found on imperfectly creosoted timber, especially sleepers, railroad ties, and transmission poles, but is uncommon in buildings. It can cause fairly rapid decay with substantial loss in weight in most conifers. In the early stages of attack, there is little alteration of the wood, but later it becomes darker in color and cracks both along and across the grain. This fungus has the ability to methylate aromatic substances, and volatile metabolic products such as methyl cinnamate and methyl p-methoxy cinnamate have been isolated from Scots pine sapwood decayed by it. This special property may partly account for the resistance of this fungus to creosote. Solutions containing up to 4 per cent of creosote are tolerated (4).

Coniophora cerebella: This is one of the commonest fungi that causes decay of wood in damp places, and it has been occasionally reported as responsible for a butt rot in conifers. In the early stages of attack, the wood shows a pronounced discoloration. Later, a brown cubical rot develops.

Experimental Procedure

The Scots pine test pieces were end-matched blocks 5 cm. by 2.5 cm. on the end-grain section and 2.5 cm. along the grain. Each consisted partly of sapwood and partly of heartwood, the two parts being barely distiguishable visually on the freshly prepared air-dry material. The sapwood-heartwood boundary on each block was clearly delineated in pencil for future reference, and test material was then autoclave-sterilized for 30 minutes at a pressure of 15 pounds per square inch. This heat treatment had no effect on the benzidine color reaction.

Next the blocks were planted directly on Kollé flask cultures of the test fungi growing on 5 per cent malt agar, two blocks in each flask, and incubated at 22° C. Half of the flasks were removed and the test pieces examined after 3 months, and the remainder after 6 months. The benzidine reagent was applied immediately to the blocks after their removal from test and again after air drying in the laboratory. These observations are summarized in Table 1.

Results

After three months of exposure to fungal attack, the color reactions of the moist samples (just after removal from the incubator) still showed distinction between sapwood and heartwood, but in the *Lentinus* blocks the sapwood-heartwood boundary was becoming obscure. Repetition of the tests after the blocks had been allowed to dry out in the dark generally gave rather duller colorations with less distinction between sapwood and heartwood than in the moist material.

After six months of exposure, the heartwood still produced a red or reddish-orange reaction except with *Lentinus* blocks, which gave a brown color similar to the sapwood. In the *Polystictus* blocks, the sapwood gave a distinctly brighter yellow than in the control. With *Coniophora,* fungal discoloration obscured the reaction. This was largely so with *Fomes,* but here and there unstained areas and superficially stained areas, which could be scraped clean, yielded a pale orange-brown reaction distinct from that of the heartwood. The difference between the two white rot fungi, *Fomes* and *Polystictus,* in their effect on the sapwood reaction is worthy of note.

In general, the effect of fungal attack is to darken or obscure the sapwood reaction, largely if not entirely, because of the darkening of the wood. It gradually changes the heartwood reaction from red, through reddish-browns, to brownish colors hardly distinguishable in some cases from the reactions of the decayed sapwood.

It should be emphasized that the test procedure was severe, and the blocks in which the heartwood failed to give a distinguishing coloration had reached an advanced state of decay. The wood was cracked, shrunken, and distorted.

It is of interest to note that the red substance produced by the interaction of the benzidine reagent with pinosylvins is quite stable; test streaks made on the blocks prior to exposure to fungal attack still showed the red coloration substantially unchanged in well-rotted wood.

Test streaks were also made on Scots pine sapwood that had been severely attacked by blue stain. No significant change in reaction color was observed beyond that due to the darker appearance of the affected wood.

To obtain some quantitative assessment of the extent of decay, a parallel experiment was carried out on blocks from the same board but consisting of sapwood or heartwood only. The oven-dry weight of these blocks was determined initially and again on half of the blocks after a period of 3 months and on the remainder after 6 months of exposure to the test fungi under precisely the same conditions as in the main experiment. The weight-loss figures are included in Table 1.

Experience with the benzidine test in the Mycology and Wood Preser-

Table 1.—OBSERVATIONS ON SCOTS PINE BLOCKS AFTER EXPOSURE TO FUNGAL ATTACK

	After 3 months of exposure							After 6 months of exposure						
	Benzidine reaction				State of decay	Dry weight Loss, per cent		Benzidine reaction				State of decay	Dry weight Loss, per cent	
	Moist condition		Air-dry condition					Moist condition		Air-dry condition				
ngus	Sapwood	Heartwood	Sapwood	Heartwood	Appearance	Sap	Heart	Sapwood	Heartwood	Sapwood	Heartwood	Appearance	Sap	Heart
F. es annosus (a ite rot)	Yellowish-brown	Reddish-orange	Pale orange-brown	Reddish-orange-brown	Both sap and heart only slightly decayed. Sap with orange to brown colorations.	13	7	Orange-brown except where obscured by fungal colour.	Reddish-orange with brown patches	Chocolate brown	Reddish-orange	Further decay in sap and heart; slightly more advanced in sap, which also showed orange to brown colorations.	27	15
P. -tictus ve olor (a ite rot)	Bright yellow to yellowish-brown	Red	Bright yellow	Red	Decay similar to above. No distinctive colorations.	20	2	Bright yellow	Red with brown patches	Bright yellow	Red	Decay as above.	37	8
Le nus lep us (a own rot)	Yellowish-brown	Orange (yellowish brown in outer heart)	Brown	Only slightly more reddish than sap	Sap severely decayed, showing cracking and distortion; heart moderately decayed.	21	22	Brown	Brown	Brown	Brown	Sap and heart both became pale brown and severely decayed, showing shrinkage and distortion.	38	35
Co phora cer lla (a brown rot)	Pale brown (barely distinct from heart reaction in one block)	Red (paler in outer heart)	Pale brown	Red (brownish and barely distinct from sap in one block)	Sap already severely decayed, brown in color, and shrunken. Heart only partially decayed.	25	1	Brown fungal stain obscured any reaction.	Red to brown	Brown fungal stain obscured any reaction.	Red (brown where rotted)	Sap severely decayed, dark brown in color and shrunken. Outer heart moderately decayed; inner heart not obviously decayed.	43	14

tion Sections of the Laboratory has shown that preservatives may affect the benzidine test. They sometimes tend to mask the reaction and sometimes, notably with creosote and its derivatives, produce a reddish coloration in sapwood as well as in heartwood. This effect is not generally apparent in old treated timbers, which suggests that the reaction is connected with some of the more volatile components of the preservative.

Special chemical investigation may be required in some cases to establish whether preservative is affecting the benzidine reaction, but in practice the complicating effect of preservatives has not proved to be of much importance.

Conclusions

The present series of observations indicate the following points bearing on the problem of recognizing sapwood and heartwood in pine timber affected by fungal attack:

1) Unless the timber has been treated with certain preservatives, a reddish benzidine reaction invariably indicates heartwood.

2) The sapwood reaction changes as decay proceeds, normally to some shade of brown, but in the case of *Polystictus* to a bright yellow. There is no evidence that it ever becomes reddish. Except with *Lentinus,* which rapidly causes substantial decay, a recognizable heartwood reaction is still obtained after fungal attack has been in progress for a considerable period. When an advanced stage of decay has been reached, both sapwood and heartwood usually give a similar brownish reaction devoid of any red tinge.

Supplementary observations on other pine samples attacked by the same strain of *Lentinus* as was used in the present tests have shown that a red reaction may be obtained after considerably greater weight losses have occurred than those here recorded. The reason for such variation has not been investigated; it may be due merely to differences in the original pinosylvin content of the wood. The practical implication of such variation is that the benzidine tests should be hopefully applied, even when the samples under investigation show advanced decay, for in some cases a reddish heartwood reaction may still be obtained.

3) Although fungal attack eventually renders the benzidine test ineffective, in practice it should sometimes be possible to reach a conclusion by carefully examining the affected timber for portions less severely decayed, since the earlier stages of attack do not seriously upset the test. In many cases, such examination may succeed in establishing whether any heartwood is present, although it may not be possible to say how much. The rate of attack under comparable conditions is usually greater in sapwood than in heartwood, and if both are present the position of the sapwood-heartwood boundary may be indicated by a fairly abrupt change in the degree of rotting or fungal discoloration of the wood.

4) Certain preservatives give a reaction similar to that of heartwood, and this has to be borne in mind in deciding the significance of a reddish benzidine reaction given by a sample that may have received preservative treatment. In practice, careful visual examination, supplemented by chemical tests if necessary, can be carried out to determine if preservative is present.

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The Effect of Temperature on the Electrical Resistance of Wood[1]

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The variation of dc electrical resistance of 3 species of wood was studied at several moisture contents. At constant moisture, the log of resistance varied linearly with the reciprocal of absolute temperature. Exponential equations were developed to relate activation energy to moisture content. Effect of temperature variation of moisture meter readings is discussed.

UNTIL RECENTLY, VERY LITTLE WORK has been done on the effect of temperature on the direct-current electrical resistance of wood. Investigations within the last 20 years have shown that the temperature effect is pronounced, and that more study is needed before this effect can be accurately evaluated.

Since most electric moisture meters operate on the electrical resistance principle, the readings obtained are affected by the temperature of the wood as well as the moisture content. Thus, proper temperature corrections must be applied to meter readings in order to obtain accurate moisture content values, particularly when such meters are used to monitor the moisture content of wood during the drying operation in a kiln. The need for accurate temperature correction data, therefore, is important to utilize fully the inherent accuracy of electric moisture meters.

Dry wood is essentially a non-conductor of direct-current electricity, and conducts only when moisture is present. Therefore it may be treated as a dielectric material under currently accepted theories. Since the electrical properties are largely dependent upon the moisture in wood, electrical studies are expected to shed further light on the important problem of wood—water relationships.

The purpose of this investigation was to continue studies of the temperature effect on direct-current resistance of wood that were initiated by Skaar (9)[3] at Yale University School of Forestry, and continued by Andersson (1) at the State University College of Forestry at Syracuse University. Specifically, this study was made to obtain a better relationship for the activation energy of wood as a function of moisture content, and to find whether this relationship differed with species.

Literature Survey

Several investigators (1, 2, 8, 9) have found that in wood, ice, and some textiles a plot of the logarithm of resistance versus the reciprocal of absolute temperature yields a straight line, with the resistance decreasing as the temperature increases. A theoretical explanation of this linear relationship was presented by Clark and Williams (2), who suggest that electrical conductivity in wood is an ionic process rather than an electronic one as in metals. Two forms of ions are present in the wood structure: bound ions whose number is dependent upon the temperature, and free ions, the only ions able to conduct a charge. Clark and Williams define the energy required to release one mole of bound ions, thus enabling them to conduct an electric current, as the activation energy, E, and present the derivation of the following relationship:

$$E = 4.576 \times \text{slope} = 4.576 \times \frac{d(\log R)}{d\left(\frac{1}{T}\right)} \qquad (1)$$

where E is the activation energy in cal./mole, R is the resistance in ohms, and T is the absolute temperature in °K. The term $d(\log R)/d(\frac{1}{T})$ is the slope of the $\log R$ versus $\frac{1}{T}$ curve. For wood at a constant moisture content, the slope is constant since the curves are straight lines. The work of Skaar (9) and Andersson (1) shows, however, that these slopes change with moisture content changes, and that increasing moisture contents produce decreasing slopes and, consequently, lower activation energies. Skaar's results show an apparently linear relationship between E and moisture content; however, the moisture content range was relatively small and a curvilinear relationship could have been used just as well. Andersson also assumed a linear relationship, but the slope of his curve was considerably lower than that obtained by Skaar. Here again the moisture content range covered was small, and a curvilinear function might have been used. Also, Andersson's results came from averaging the data of six different species while Skaar worked with Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] only.

In studying the direct-current electrical properties of wood, factors other than moisture content and temperature must be considered. Murphy (5) has shown that the magnitude of the applied voltage influences the resistance measurements in cotton. He found that as the voltage decreases the resistance increases. Since both wood and cotton are cellulosic materials, this voltage effect, called the Evershed effect, may also occur in wood.

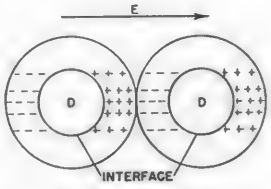

Fig. 1.—The effect of an electric field on the distribution of adsorbed ions at the interface between a dielectric material, D, and conducting medium.

Another effect to be considered is the complex nature of electrical conductivity in hygroscopic dielectrics. Murphy and Morgan (7) point out that, when a static electric field is applied to a dielectric, a current flows only for a certain length of time. The time of current flow is that required for the particles in the material to reach a fully polarized condition. In practically all real dielectrics, the current flow does not drop to zero after polarization, which would be the case for an ideal material. Most real materials contain some free ions that are capable of conducting a current, and the final constant current flow through

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[2] The author expresses his appreciation for assistance to Dr. Christen Skaar, State University College of Forestry at Syracuse.

[3] Numbers in parentheses refer to the Literature Cited at the end of this paper.

the material is determined by the conductivity of these free ions.

In most previous work where polarization has been considered, emphasis has been placed on interfacial or ionic polarization to explain the time dependency of the current flow. Though other types of polarization may occur, it is assumed that they play an insignificant part in direct-current measurements. Murphy and Lowry (6) go into this ionic polarization in more detail, and point out that electrical conduction in dielectrics is along conducting paths at interfaces between the insulating material of the dielectric and an adjoining conducting layer. The conducting layer is usually either water containing ions, or ions directly adsorbed on the dielectric material. Under the influence of an electric field, the adsorbed ions tend to migrate to a polarized distribution (Fig. 1). Since the degree of polarization is dependent upon the length of time the electric field is applied, the current flow associated with polarization varies with time.

An analogous electrical network (Fig. 2) may be set up which predicts such a time-dependent current flow. The change in current with time is due to the time constants of equivalent parallel resistance-capacitance circuits plus the accumulation of electrolytic products at the electrodes. The assumption is that this time-dependent current component, due to adsorbed ions and molecules, predominates when the conductivity is low and the current is measured a short time after voltage application. The accumulation of electrolytic products is important when the conductivity is high and in the later stages of the adsorption current. Thus, it is evident that the current flow immediately after voltage application has two components: 1) a true direct-current, plus 2) a polarization current that is time dependent.

If the assumption is made that the polarization component is small in comparison to the true direct-current component, fluctuations in the polarization current with time do not appreciably change the total current flow. Thus, measurements made immediately after voltage application give a good approximation of the direct-current conductivity because this component predominates. Furthermore, a minimum of electrolytic products have accumulated near the electrodes.

Test Specimens

The specimens used were selected from some extra material previously prepared by Andersson (1). This material originally was cut from boards in the Project I Wood Collection, Department of Wood Technology, State

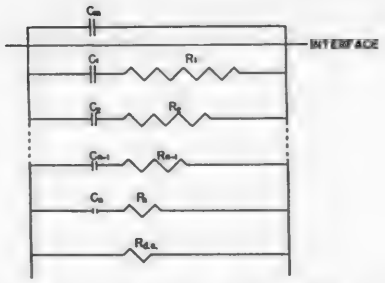

Fig. 2.—An electrical network that predicts a current flow which is time dependent similar to that observed in wood. C_m is the capacitance due to polarization of dielectric molecules, C_1 ——— C_n are capacitances due to the redistribution of adsorbed ions on the surfaces of a dielectric, R_1 ——— R_n are resistances equivalent to frictional forces which impede the process of forming a polarized distribution of adsorbed ions, and $R_{d.c.}$ is the direct-current resistance. As the distance from the interface increases, C_1 ——— C_n and R_1 ——— R_n decreases.

University College of Forestry at Syracuse University. The specimens were machined to dimensions of about 0.43 by 2.3 by 2.3 cm., and the grain was oriented so that the current flow was in the tangential direction.

Six specimens for each of three species, Douglas-fir, yellow-poplar *(Liriodendron tulipifera* L.*)*, and sugar maple *(Acer saccharum* Marsh.*)*, were prepared with two coats of silver paint (fast-drying flexible silver micropaint SC13, manufactured by Micro-Circuits Co., Buffalo, Mich.) on the broad faces for electrodes. The first coat was allowed to dry about 48 hours before the second coat was applied. The weight of paint applied to the specimens was determined for each sample by weighings made before and after the paint application at conditions of constant temperature and humidity (after a suitable period of time was allowed to permit the solvent to evaporate).

The specimens were conditioned to a moisture content of approximately 12 per cent in a humidity room maintained at a temperature of 75° F. and a relative humidity of 70 per cent.

Measurements

The method used to obtain data on the variation of electrical resistance with temperature was essentially that described by Andersson (1) as his Method II. In this method, the specimens were originally conditioned to approximately 12 per cent moisture content, then wire leads were connected to the silver-painted faces and the whole assembly was wrapped in Saran Wrap (vinylidene chloride, a commercial plastic with good vapor-barrier qualities). The specimens were allowed sufficient time to reach an equilibrium moisture distribution, which was checked by taking resistance

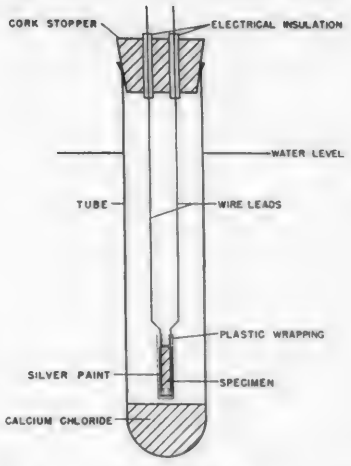

Fig. 3.—A diagram of the arrangement of the test specimen in the test tube.

readings until a constant value was reached. They were then placed in large test tubes (one specimen to a test tube) containing a small amount of calcium chloride to prevent condensation in the tubes at the lower temperatures (Fig. 3). The tubes were closed by a cork stopper through which the two wire leads were passed. The test tubes were then placed in a variable-temperature water bath (Fig. 4). The bath container was equipped with heating and cooling coils, with the heating coils controlled by a thermistor bridge circuit and a Versatrol (Fig. 5).

Basically, the control circuit was a Wheatstone bridge with two VECO 51A4 Thermistors connected in parallel to form one arm of the bridge. Each thermistor was placed in a small glass tube that had one end sealed, and the tubes were placed near diagonally opposite corners of the bath so that better sampling of the bath temperature could be obtained. Resistance R_2 was a fixed 2700 ohm resistor, and R_3 and R_4 were variable decade resistors. The power for the bridge was

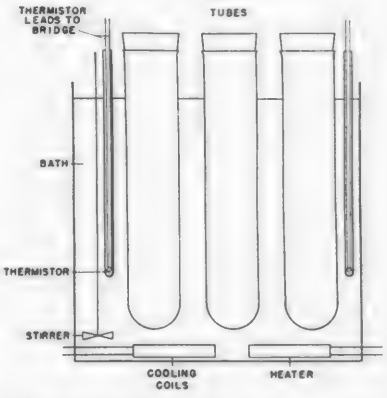

Fig. 4.—A diagram of the temperature-control bath used to maintain constant temperature of the test specimens.

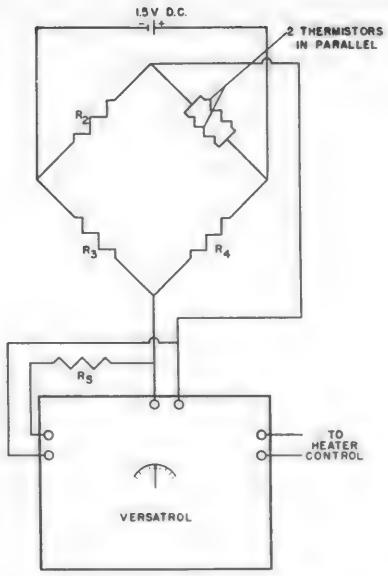

Fig. 5.—The Wheatstone bridge circuit used for controlling the bath temperature. R_2 was fixed at 2700 ohms, R_3 and R_4 were variable decade resistors used to obtain balance at different temperatures. R_5 was a protective shunt for the meter galvanometer.

supplied by three 1.5-volt dry-cell batteries connected in parallel. The output of the bridge was connected to a Versatrol meter relay, manufactured by Assembly Products, Inc. The Versatrol unit controlled the heating coils in the bath.

For each desired bath temperature, values of R_3 and R_4 were computed so that the bridge would be in balance at that temperature. If the bath temperature was too low, the output voltage from the bridge activated the meter relay, which turned on the heating coils. When the bath temperature reached the balance point for the bridge, the meter relay shut off the heating coils. With this arrangement, bath temperatures could be maintained within about $\pm$ 0.1° C.

The first temperature run was made on samples conditioned to a moisture content of approximately 12 per cent. The wrapped specimens in the test tubes were conditioned to an initial bath temperature of 12.7° C. After the specimens were conditioned the electrical resistance was measured for each specimen with a General Radio Co. megohmmeter, type No. 1862-A. Four different output voltages were used—50, 100, 250 and 500 volts—and a set of resistance readings was recorded for each voltage.

After the resistance measurements were made at 12.7° C., the bath temperature was raised stepwise to 23.3°, 34.7°, 47.0°, and 60.3° C. A series of resistance measurements was taken at each temperature. These particular temperatures were selected for convenience since they correspond to uniformly spaced values of the reciprocal of absolute temperature. The specimens were allowed to come to temperature equilibrium at each step. This was checked by taking sample resistance measurements at time intervals of about five minutes. When these measurements became constant, it was assumed that equilibrium had been attained, and a complete series of resistance measurements was made. Following the readings at the final temperature step, the specimens were immediately removed from the test tubes, cooled, and weighed to determine if any moisture loss had occurred during the test cycle.

Identical temperature runs were made at the following moisture contents and in sequence as listed: Run 2, approximately 15 per cent; Run 3, approximately 14 per cent; Run 4, approximately 9 per cent; Run 5, approximately 11 per cent; and Run 6, approximately 18 per cent. The exact moisture contents of the individual samples were calculated after the final test.

In addition to the experiment described above, a brief investigation was made of the contact resistance of the silver paint on wood. Ten Douglas-fir specimens were prepared with dimensions of 1 by 2 by 2 cm. The 1 cm. distance was measured along the grain. The 2 cm. lengths were oriented in the radial and tangential directions. Of the 10 specimens, five were randomly selected for treatment and the remaining five were used as controls. All specimens were conditioned in a constant temperature and humidity room to about 12 per cent M. C. The radial faces were painted with one coat of silver micropaint, which was allowed to dry for two days. Resistance measurements were then made on all specimens with a megohmmeter, which produced 500 volts output.

The five specimens selected for treatment were then split into three sections with a sharp pocket knife and mallet. The specimens were evenly divided with the splits running in the radial direction. The newly exposed radial faces were given a single coat of silver micropaint, which was allowed to dry for two days. The three segments of each original specimen were then placed together so that the silver paint on the newly exposed faces made contact, and the resistance was again measured.

Finally, both control and treated specimens were placed over a bath of water in a closed container and conditioned to a moisture content of 20 to 25 per cent. Resistance measurements were again made on all specimens.

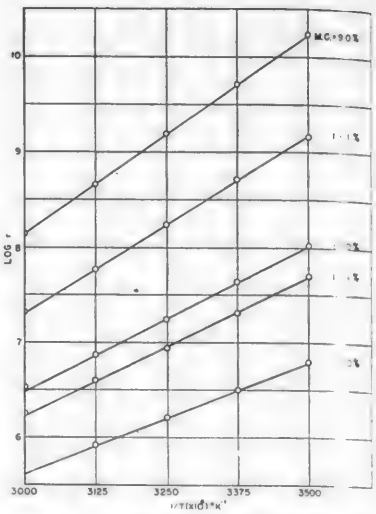

Fig. 6.—A plot of experimental data for Douglas-fir specimen DF1.

Treatment of Data

In the main experiment, the logarithm was calculated for each resistance reading. To compare the results with those of other workers it was necessary to calculate the resistivity. This was calculated by the relationship

$$r = \frac{A}{L} R \qquad (2)$$

where R is the total resistance in ohms, r is the resistivity in ohm-cm., A is the cross-sectional area of specimen cm.², and L is the length in cm. On converting to the logarithmic form:

$$\log r = \log \frac{A}{L} + \log R \qquad (3)$$

Thus the $\log r$ was easily determined by adding the constant factor $\log \frac{A}{L}$ to the values of $\log R$ for each specimen.

The value of $\log r$ was plotted against the reciprocal of absolute temperature $\frac{1}{T}$ for each specimen at each of five moisture contents. In each case, the data produced a linear relationship (Fig. 6).

The slope of each curve, $d(\log r)/d(1/T)$, was found from the original plots and tabulated by specimen number and moisture content. A plot of this slope against moisture content on semi-log paper showed that the logarithm of the slope $d(\log r)/d(1/T)$ decreased linearly with increasing moisture content.

By means of this relationship, straight-line curves were fitted to the data by the method of least squares. Fig. 7 shows the result for Douglas-fir, together with the experimental data. For the three species studied the resulting equations were:

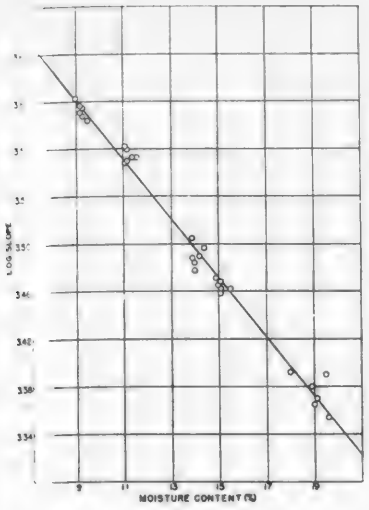

Fig. 7.—A plot of log d(log r)/d(1/T) against moisture content for all Douglas-fir specimens.

Douglas-fir $\log d(\log r)/d(1/T) = -0.0249M + 3.8455$ (4)
yellow-poplar $\log d(\log r)/d(1/T) = -0.0227M + 3.8299$ (5)
maple $\log d(\log r)/d(1/T) = -0.0209M + 3.8043$ (6)

where M is the moisture content of the wood in percent.

Since the activation energy E is equal to the product of 4.576 times $d(\log r)/d(1/T)$, by equation 1, it is clear that similar relationships can be derived that will relate the activation energy to wood moisture content. If equation 1 is combined with equations 4, 5 and 6 and the results rearranged into the exponential form, the resulting empirical equations relating E to moisture content for each species are:

for Douglas-fir $E = 32{,}061\ (1.059 - M)$ cal./mole (7)
for yellow-poplar $E = 30{,}930\ (1.054 - M)$ cal./mole (8)
for maple $E = 29{,}160\ (1.049 - M)$ cal./mole (9)

A plot of equation 7 is shown with the experimental data (Fig. 8).

The results of the contact-resistance experiment indicated that, at moisture contents near 12 per cent, the contact resistance of the silver paint on wood was negligible compared to the wood resistance. In the 20 to 25 per cent moisture content range, the results were inconclusive. Thus, at the highest moisture content, the contact resistance may have had some effect, but a more detailed investigation would be necessary to establish the magnitude of this effect.

Discussion

One of the sources of error in this technique is the loss of water from the wood at the higher temperatures. Weighings made before and after each temperature run showed that the maximum moisture losses were on the order of 0.2 per cent moisture content, which was near the limit of precision of the moisture content determinations. It was concluded that moisture content changes in the specimen were negligible because of the efficiency of the vapor-barrier wrapping.

Another possible source of error is the wood moisture content change within the plastic wrapping due to the evaporation of water from the wood cell wall into the vapor phase in the cell cavities and air spaces surrounding the wood. As an extreme case, it may be assumed that the total air space within the package is equal to the volume of wood in the package, or 2.275 cm.^{3}. At 60° C., saturated water vapor has a density of 0.1305×10^{-3} grams per cubic centimeter. Therefore, the weight of saturated water vapor in a volume of 2.275 cm.^{3} is 0.297×10^{-3} grams, or 0.297 milligrams. If it is assumed that all of the water in vapor form came from the cell wall, the weight of water in the cell wall should show a maximum decrease of 0.297 milligrams. Since the weighings were made only to the nearest milligram, such a weight change could not be detected, and evidently would have a negligible effect on the moisture content.

The results of this study show that, at constant moisture content, an increase in temperature reduced the electrical resistance of the wood. This temperature effect is more pronounced at the lower moisture contents, as is clearly shown by the curve of equation 7 (Fig. 8). When moisture meter corrections are calculated, however, high moisture contents result in the largest correction factors. This inversion is due to the shape of the curve of resistance versus moisture content for wood. Temperature corrections were calculated from the results of this study, and were compared with those published by the U. S. Forest Products Laboratory (3). For a temperature change of 10° F. and wood moisture content of 9 per cent, the FPL curves show a correction of 0.5 per cent, while the calculated value is 0.6 per cent moisture content. At 19 per cent wood moisture content, FPL data give a correction of 1 per cent per 10° F., while the calculated value is 0.86 per cent per 10° F. Thus the results agree well with temperature correction data presently in use.

The results of this study were compared with those of Skaar (9), Andersson (1), and Keylwerth and Noack (4). A comparison of the relationships between E and moisture content found by Skaar and Andersson and those presented in this paper is shown in Fig. 9. The curve determined by Skaar intersects the curve determined in this paper (equation 7) in the region of overlapping moisture contents of the two experiments. However, Skaar's data indicate a slightly steeper curve in the 6 to 10 per cent moisture content range than the extrapolated portion of equation 7 shows.

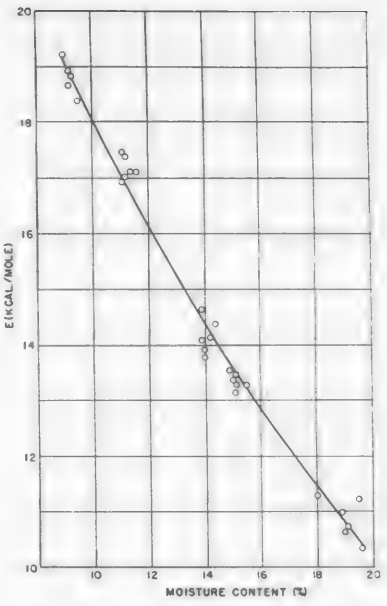

Fig. 8.—The curve of equation 7 together with the experimental results for Douglas-fir.

The curve determined by Andersson has a lower slope than either of the others. This curve was determined by averaging the data of six different species, however, and therefore may not be directly comparable to data for Douglas-fir only.

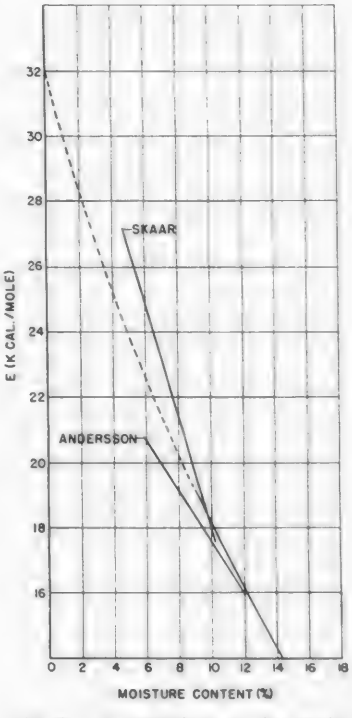

Fig. 9.—A comparison of the results of Andersson (1), Skaar (9) and equation 7. The dotted line indicates an extrapolation of equation 7 over a moisture content range for which no data were obtained.

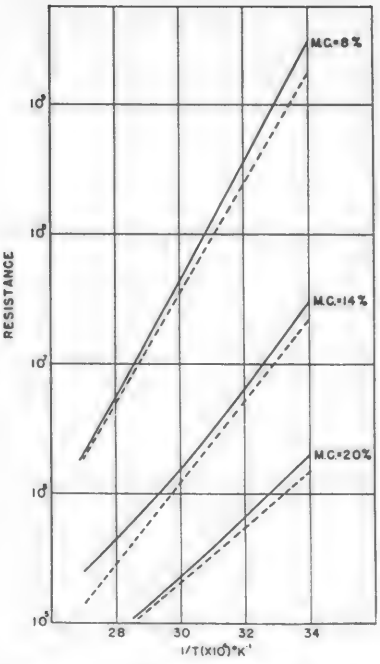

Fig. 10.—The solid lines are experimental results obtained by Keylwerth and Noack (4) for spruce, while the dotted lines are curves whose slopes were predicted by equation 7.

The curves of the logarithm of resistance versus the reciprocal of absolute temperature determined by Keylwerth and Noack for spruce were reproduced (Fig. 10). The dotted lines are curves with slopes determined by equation 7 for Douglas-fir. It is evident that the curves of Keylwerth and Noack are slightly curvilinear in contrast to the linear relationships found by Skaar and Andersson and those presented here, but the general agreement is good.

The relatively good agreement between the data of Keylwerth and Noack, and slopes of the *log r* versus *1/T* given by equation 7 suggests that the difference between species may be very small. Thus, a detailed statistical study would be necessary to determine whether differences were significant. The curves of equations 7, 8 and 9 for Douglas-fir, yellow-poplar, and maple (Fig. 11) also show that the differences among these three species are relatively small.

Another interesting comparison is made by setting M in equations 7, 8 and 9 equal to zero and obtaining the following activation energies at zero moisture content: Douglas-fir—32,061 cal./mole; yellow-poplar—30,930 cal./mole; and maple—29,160 cal./mole. Clark and Williams (2) made experimental determinations of E at the oven-dry condition and obtained the following values: birch—22,900 cal./mole; mahogany—30,600 cal./mole; red oak—28,400 cal./mole; and Sitka spruce—32,000 cal./mole. Equations 7, 8 and 9 again agree fairly well with experimental data, and it appears that the activation energy varies exponentially with the moisture content of the wood.

During the experimental work, data were obtained from which the Evershed effect could be evaluated. A study of the data shows very little change in the value of the resistance for voltages in the range of 50 to 500 volts for electrode spacing of 0.43 cm. The data did exhibit the expected increase in R as the voltage dropped. The increase was so slight, however, that statistical analysis would have been required to determine whether the differences were significant. Since the change in R was so small in the 50 to 500 volt range, the voltage applied does not appreciably affect the value of R. Not investigated was the effect of lower voltages (0–50 volts) which, on the basis of results obtained from experiments with textiles, would be expected to have a greater effect on the resistance.

Conclusions

The results agree in general with those found by other workers. The data indicate that direct-current conductivity in wood is ionic in nature, and that temperature plays an important role in the conduction process. Because of this temperature influence on wood resistance, corrections must be applied to moisture meter readings in order to obtain accurate results.

The data also indicate that the activation energy increases exponentially with decreasing moisture content. Also the magnitude and variation of E with moisture content appears to be similar for the three species of wood studied, and comparison of this variation with the work of others suggests that species differences are small.

It is clear that further study is needed, especially on the nature of the ions involved in the current flow. At present it is not known whether electrical conduction in wood is due to the minerals present or to the wood substance itself. Also, the effect of voltage gradient should be investigated more thoroughly, since this may have a pronounced effect on the resistance values.

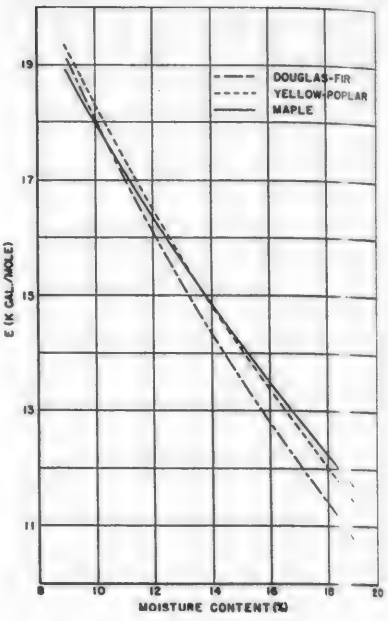

Fig. 11.—Curves of equations 7, and 9 for Douglas-fir, yellow-poplar, and maple respectively.

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Statistical Quality Control Pays Off in Woodwork[1]

ROBERT CHATEAUNEUF

Quality Control Assistant Manager, The Singer Manufacturing Co., St. Johns, Quebec

The organization of statistical quality control in a cabinet factory is traced, based on the principle of quality cost vs. production value. A plant-wide quality-consciousness was created first. Quantity of inspection was replaced by an emphasis of superior quality. Control charts were used and performance reported at all levels, with resulting savings.

BUILDING AND MAINTAINING QUALITY is a growing problem. Day by day, products and processes become more complex, profit margins narrower. At the same time, specifications become more demanding. A final inspection may maintain the quality reputation of a product, but it does nothing to reduce excessive inspection, waste and scrap losses, or make more effective the use of the personnel and equipment involved. The introduction of the Singer quality control program began a year and a half ago, under the guidance of Mr. R. C. Calahan.

The adoption of statistical quality control techniques in the factory is largely responsible for the construction of a higher quality at less cost. The following factors have contributed the most to the success of the quality control program, and will be the framing of this paper:

1) The determination of the quality cost in dollars.
2) Creation of a plant-wide quality atmosphere.
3) Samples establishing quality standard limits.
4) Reduction and replacement of 100 per cent inspection by sampling.
5) Daily quality evaluation of the finished goods produced.
6) The use of statistical quality control charts.
7) Quality performance reports to all levels of management.

Before developing these points, the basic principles of statistical quality control should be reviewed.

[1] Presented at Session XII, Quality Control, FPRS 11th National Meeting, June 23-28, in Buffalo, N. Y.

The Author: Robert Chateauneuf was graduated from the Montreal Technical School, and spent three years in engineering work before joining Singer in 1948. He was given responsibility for introducing quality control in the plant in 1955. His articles have appeared in the *Journal* and other publications.

Principles of Statistical Quality Control

Statistical quality control is a method or a management tool whereby management is enabled to establish a yardstick to measure the variability of a process or part. Everything occurring in nature or made by man and machine varies. No two things are exactly alike, if sufficiently precise measuring instruments are usual. Once this concept can be grasped, the barrier to the use of statistical quality control methods is broken.

Many prefer to think in abstract terms: to think that 2 times 2 is exactly 4 and never approximately 4. They may have difficulty in accepting the fact that all things vary. A 6-foot rule is relied upon as being exactly 6 feet long but, if measured precisely enough, none would be exactly 6 feet in length. Once this concept of variability is accepted, then there is a need for some way to measure the variation. Once variation may be measured and analyzed, it then will be possible to control and interpret it.

Every characteristic of an item will have a normal or expected variation inherent in the item, and other abnormal or unexpected variation caused by some extraordinary cause or event. Statistical quality control provides a means of separating the normal variations from the abnormal ones. It is than possible to determine when a process is operating as well as can be expected, and when it is not.

These normal variations are referred to as having been caused by chance or luck. Shooting dice or playing a slot machine might be considered games of chance or luck to the customer, but not to the gambling house. The difference is that the customer does not attempt to measure the expected variations or the odds, while the professional gambler does. Too often, decisions are based on opinions rather than on facts. In other words, businesses or jobs are being gambled with without knowing the odds. A management action is not worth more than the adviser dependability. By proper application of statistical quality control the odds can be determined. It is all tied up in knowing how much variation to expect. Then corrective action will not be taken until this expected variation pattern has been exceeded. Instead of developing ulcers trying to win a hopeless battle with sorting operations, attention and efforts may be devoted only to the variations over which some measure of control should be exercised.[2]

Determination of Quality Cost in Dollars

The quality cost is the ratio of the money spent for maintaining the quality against the cost value of the merchandise produced.

The quality cost is found by adding the following factors:

1) Departmental inspection and repair cost (daywork and piecework).
2) The value of rejects at the operation scrapped.
3) Centralized inspection and laboratory operating cost.
4) Fixed charges for individuals attached to quality, such as holidays, benefit and retirement plan, unemployment insurance and bonus.

The tabulations of aforementioned factors should be as precise and complete as possible. The quality cost figures will reveal the gravity of the situation. It will also indicate without any doubt in which area it is most urgent to start quality control. The quality cost figure will be an indication of the progress attained for years to come.

What has been the performance at the Singer factory for the last three years? In 1954, 6.5 cents was spent to maintain the quality for every dollar of woodwork goods produced. This per cent is the ratio of the quality cost over the production value. In 1955, the production had increased but the

[2] Details of the mathematical formulae will not be discussed. This information is available in several excellent books

quality cost almost moved parallel to the production value. Quality control was introduced at the end of 1955, and 12 to 14 months later another pattern had developed. The quality cost no longer moved parallel to the production value. The 6.5 cents and 6.2 cents spent for every dollar of production dropped to 4.1 cents, representing a saving of $56,000.00 over the quality cost of 1955. Comparing the present quality cost with the customary parallel move with the 1956 production value would represent an appreciable saving of $90,000 to $100,000. This saving is not detrimental to quality, which was maintained and improved. (Fig. 1)

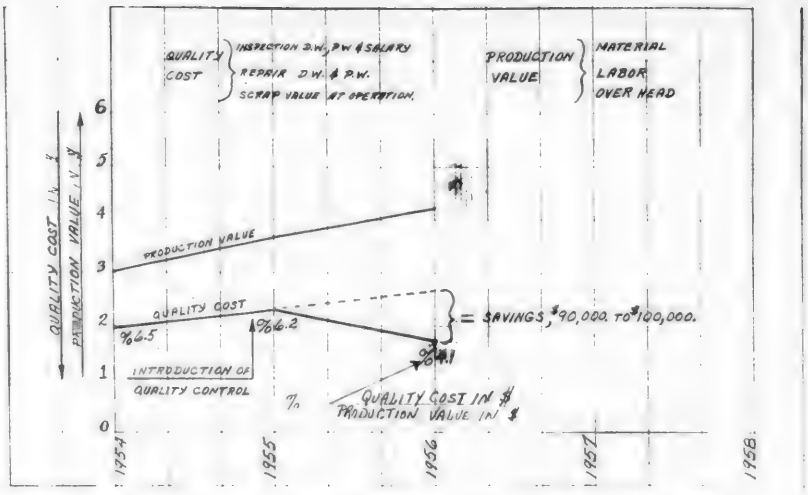

Fig. 1.—Yearly cabinet division quality cost against production value.

Creation of a Quality Atmosphere

In the factory, top management was sold on statistical quality control but the production group was not. Therefore the latter group was approached with selling ideas. The program was launched by a kick-off meeting that grouped all department managers, their assistants and foremen. A film on quality control was presented. The works manager emphasized the importance of reducing the quality cost without lowering the quality.

Tests have shown that visual 100 per cent inspection made by humans had only 80 to 90 per cent accuracy and does not give the protection necessary.

Quality control is based on the three major factors which are responsible for the construction of the quality, namely, the three M's . . . man, machine, and material. It is important to reach the operators and the machine setter as well as the material handler.

Direct quality control meetings with the operators (15 to 30 minutes in a group of 10 to 15 operators) were very effective. Pocket pencil holders with a slogan printed thereon, "Our Quality is our Security", were given to the employees.

The factory monthly paper and posters were found to be valuable tools in promoting quality atmosphere.

Define the Quality Standards

It is indispensable to define quality standard with typical samples. It was observed that operators doing a similar job have individual quality conceptions. It pays dividends if operators know exactly what is good, what can be repaired economically, and what is not acceptable.

Cabinet making, which deals with a non-homogeneous material such as wood, will require more appearance standards than furniture made with laminated decorative facing. Woodgrain imitation is made within an acceptable variation pattern. Plain wood has an unlimited decorative pattern which characterizes its distinction. To get such a distinction, the matching range should be in ratio with the retail price of the furniture. A nice color match range is difficult to obtain.

In the factory, samples were accumulated and submitted to the top and productive management, to have them draw reasonable limits of acceptability. This limit depends a great deal on the part location and the class of cabinet.

These factors are directly connected to the quality cost figures. Operators like to have samples of acceptability at their operation. It is also a gage to the newcomer, who will have poor excuses if it is not used wisely.

Reduction and Replacement of 100 Per Cent Inspection by Sampling

The so-called 100 per cent inspection is recognized to be expensive and inaccurate. It is expensive because it will absorb more labor and more gages. Quality is not something that is inspected. Quality is built into the product by the man, the material, and the machine. When thought of along this line, the inspection becomes a verification of the quality performance only and can be done by sampling. If the verification is done 100 per cent, the last operator's responsibility, which is to produce good work, is removed from him. The operators will occasionally try to deceive the inspector, who will become inaccurate in his segregation.

The responsibility of the quality bears on the operators. For operations such as touch-up (minor repairs), it was found important to have the operator identify his work with a letter punch. On small pieces, to make sure that good parts are not thrown away, a special container identifies the work with the operator and makes it possible to sample the stock thrown in the scrap and pin-point the extremists.

Inspection by Sampling

A sampling inspection program for the incoming stock was organized with a sister factory that supplied all the semi-finished stock, such as veneer panels and so forth. Each woodwork shipment has a pallet of representative samples of the entire shipment. The sampling plan is tolerating up to 4 per cent defective parts. Any item exceeding the acceptable quality level of 4 per cent is inspected 100 per cent. The surplus of defective material is then credited to the St. Johns factory.

Findings of the inspection are entered on a special form and sent to the supplier to make necessary correction.

In the wood machining department, there was a visual 100 per cent inspection for 50 items. These inspections, which kept two inspectors busy, were replaced by a roving inspector who verifies the quality of the work at its source. This became what is called process quality control.

Operators themselves remove the obviously bad parts, and the assemblers do not assemble defective parts that are beyond repair. A complete sampling is done on the stock leaving a department. If the lot has an excess of defective, it is sorted out and the labor is charged against the department at fault.

As a result, with a greater production the value of material rejected was reduced by $28,000 in 1956. Likewise, an economy of $12,000 on woodwork inspection was realized. This was achieved by eliminating unnecessary 100 per cent piecework inspection and a few daywork inspectors.

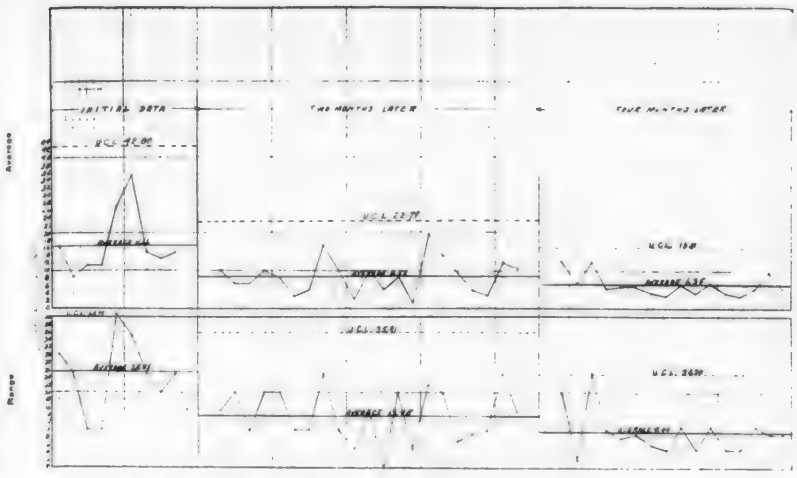

Fig. 2.—Singer quality control average and range chart for general appearance.

Daily Quality Evaluation of the Finished Goods Produced

One-hundred per cent inspection on all individual items does not build in the quality. However, this type of 100 per cent inspection has to be used for general appearance on finished products.

The story on this particular type of 100 per cent inspection is amusing.

In 1955, two inspectors were doing a fairly good job but because they were not catching everything two other inspectors were doing a second 100 per cent inspection before the packing. In the drive to reduce the factory quality cost, the two inspectors in the shipping department were removed and replaced by a statistical quality control sampling in the assembly department.

After the final 100 per cent inspection, a sample size of three cabinets of each type are selected at random, inspected and rated daily with the following demerit points system:

Incidental—Faults that will not cause failure in service, decrease life or necessitate additional servicing, such as very light bruise—*1 Demerit*

Minor—Faults on appearance and workmanship that make product less desirable —*5 Demerits*

Major—Fault which will decrease life or require excessive servicing, such as touch-up by retailer. The customer will be dissatisfied with the purchase—*20 Demerits*

Critical—Faults which may cause injury or damage. The customer will refuse to buy the product—*50 Demerits*

The quality of a cabinet is not acceptable if it has 20 demerit points or more.

An inspection report listing the defects, the demerits and the department at fault, is sent to all management levels interested. Looking at the average and range chart for general appearance, there are three quality performance pictures. (Fig. 2.)

The following reasons have contributed the most to the noted improvement:

a) Eye test to all the inspection group, the stroke sander operators, and the touch-up men.
b) Better lighting.
c) Daily sampling process inspection by roving inspectors.
d) Daily quality rating of goods ready to be shipped.

Among the above factors, a comment on the eye-test program is in order. It is a policy of the factory to have new employees pass a medical examination and have their eyes tested. According to the daily quality rating, the conclusion was reached that some inspectors did not see what they were supposed to see. Therefore, all inspectors had their eyes tested.

There again, the purpose is not to catch the faults but rather to prevent them. Hence, the eye test program was extended to the productive group. It also had a very good psychological quality effect on the labor.

Quality Performance Reports to All Levels of Management

All production areas of the Cabinet Division are covered by four process quality controllers (roving inspectors) under a quality supervisor. Beside the function of this service and policing group to evaluate the quality at its source by sampling, specific items which require control are plotted on suitable quality control charts. The frequent quality assurance observations obtained by small sampling are entered on a special form. The stock moving on trucks from one department to another has an identification production card, which is stamped by the quality controller if the lot is accepted.

From the foregoing data, a weekly summary of the quality and major defects is communicated to all levels of management.

In addition to giving top management a bird's eye view of the factory quality performance, it applies pressure on the corrective action group and also keeps the process inspector on his toes.

Twice monthly, woodwork stock ready to be shipped is unpacked and inspected by the quality manager in front of the management group. Faults are evaluated by demerits and again reported to all department managers concerned.

Every three months, a Singer New York executive office delegate makes a representative sampling inspection of the stock ready for export.

Statistical Quality Control Charts

A number of different types of charts are currently used in process quality control. These cost reduction and quality improvement tools have a very great psychological effect on the production group. It has been found that a chart placed beside an operator, picturing this performance, is worth a supervisor.

The Q.C. charts have an important distinction in the technical language of statistics. One type of chart called "Variable or Average and Range" (X & R) chart can be used only where it is possible to measure the variation, such as lacquer film and veneer thickness, glossmeter readings, and so forth. It can be used on appearance also, but with a system of demerit points. This type of chart is the most sensitive.

Two other control charts are used for attributes. One of these, called the "P" chart is used to evaluate the fraction defective, such as the results given by a go-no-go gauge. The appearance of a piece of furniture . . . it is either good or bad.

The other attribute chart, called the "U" chart, pictures the number of defects per unit, such as the number of defects on a drawer, on a cover, or on a complete cabinet.

A fourth simple control technique is the frequency distribution. This powerful tool can be used very easily. In tabulating the sizes of one or two hundred parts, the variation pattern that can be expected from a process is pictured.

The chart techniques are well explained in manuals by the quality control pioneers. A few of these charts, and what they have accomplished are shown.

The frequency distribution in Fig. 3 shows two patterns: Before and after

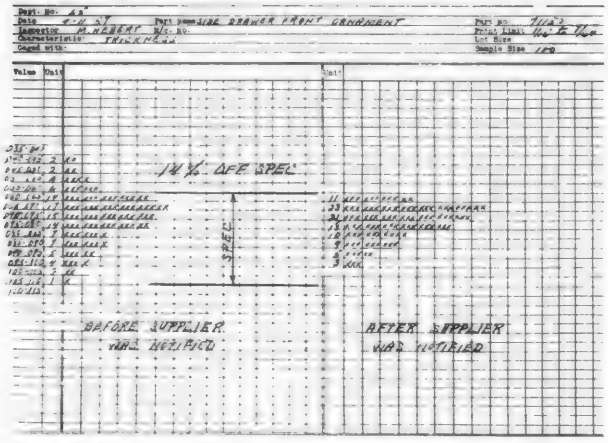

Fig. 3.—Quality control frequency distribution check sheet.

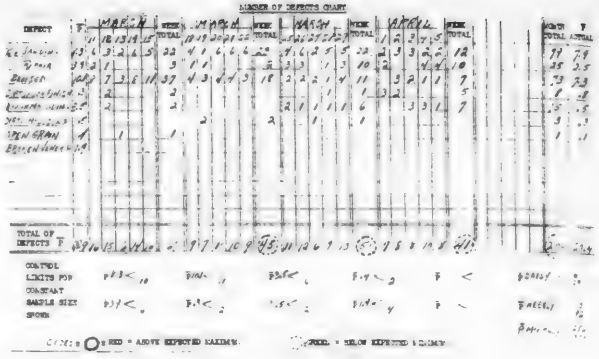

Fig. 4.—Defects per unit chart.

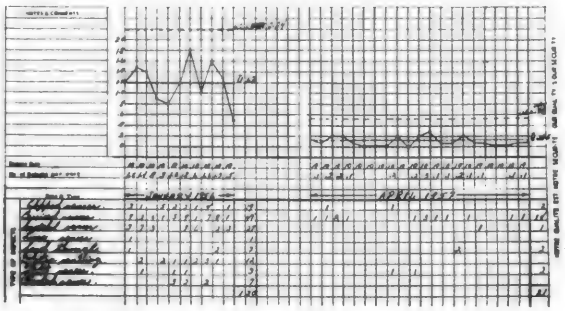

Fig. 5.—Process quality control "U" chart.

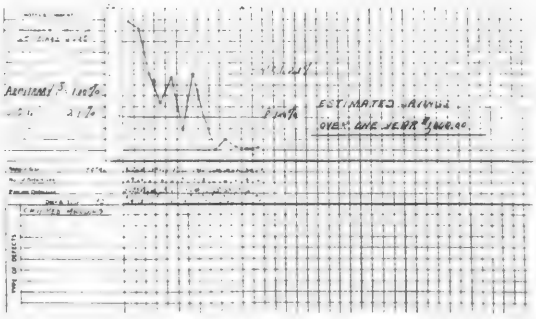

Fig. 6.—Process quality control, per cent defective, or "P" chart.

the supplier was notified. The first pattern shows that 14 per cent of the parts are off specification, while the second pattern is within an acceptable range.

A special defects per unit chart (Fig. 4) was tried out with some success. This type of chart is credited to General Electric Company. For more details, reference is made to the *Industrial Quality Control* publication, October 1955. The advantage of this method is that it is not necessary to calculate the statistical control limits. The latter are given by two numbers which are the expected maximum and minimum. This quality performance control has some merit on certain operations, although it is felt that charted curves have a stronger psychological effect on the operators.

Fig. 8 is the "U" chart used on sewing machine cabinet covers after polishing operation, and shows the quality improvement over one year. Such an improvement has reduced the touching-up operation. Such improvement was achieved through better handling, a greater desire to produce quality, and a superior polishing operation.

The "P" chart in Fig. 6 is very significant. The chipped moulding caused by the feed speed at a hinge seat operation has dropped from 3 per cent to less than 1 per cent. The operator was feeding too fast. The savings are estimated to be $1,000 per year.

The "P" chart in Figs. 7, 8, and 9 illustrate the sand-throughs of veneered panels of two different processes. The estimated savings of $23,400 reported for three items are derived from the raw material value, the veneering operations, plus labor for one year's production. This saving figure, plus the one applicable to a few similar other parts, represents approximately $30,000. This quality cost reduction is credited to the production management and the engineering department.

Fig. 10 is a chart of the average and range controlling lacquer film thickness. Fig. 11 illustrates the fact that sometimes you have to construct your own measuring device.

The instrument is set on a given corner and the micrometer is brought against the finish surface. The instrument is then removed and the lacquer under the micrometer head is washed off with a solvent on an area of approximately the size of a five cent piece. A second reading is then taken, and the difference is the dimension wanted.

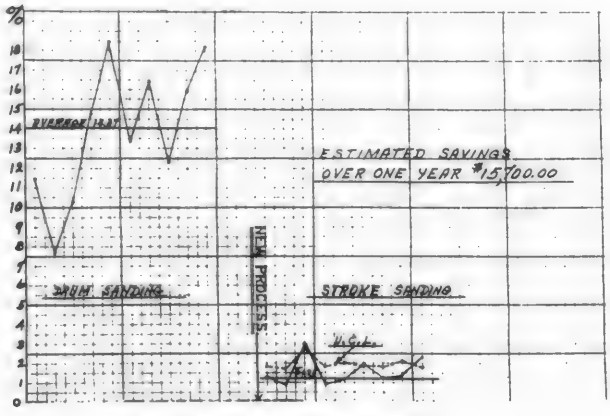

Fig. 7.—Quality control "P" chart.

Conclusion

Statistical quality control is a powerful tool with which it is possible to picture a process at a given operation.

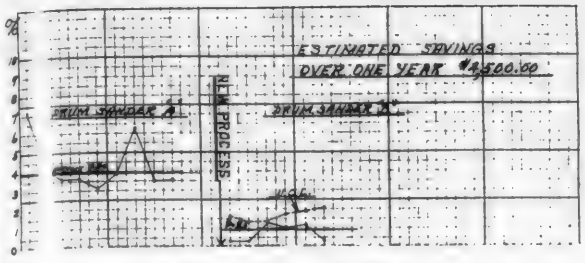

Fig. 8.—Quality control "P" chart.

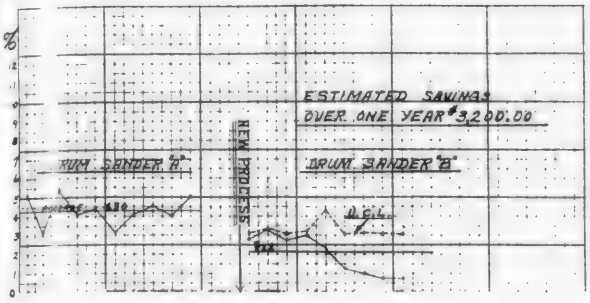

Fig. 9.—Quality control "P" chart.

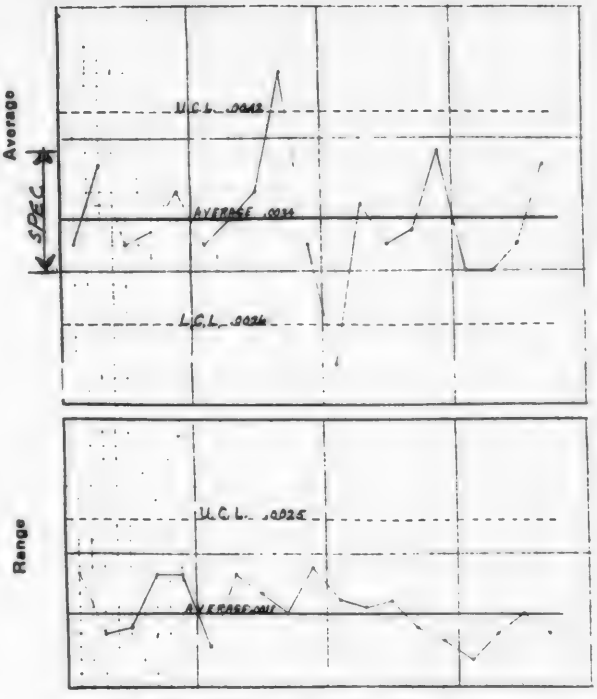

Fig. 10.—Quality control "R & R" chart.

It becomes a decision-making service on which management's actions can be based. The quality control pictures represent the expected variation pattern given by the process, whether the results are favorable or not.

These pictures, or charts, are interpreted by the impartial quality control group and are then submitted to the production and the engineering staffs for corrective action. Therefore, quality control becomes a team job and it is important to sell the quality control idea . . . not to impose it.

If speed is wanted, give the credit to the production management and engineering groups. The whole factory soon will be trying to improve the product and reduce the *quality cost,* which, after all, is the *main objective.*

The question is not "Can we afford to use quality control?" but rather, "Can we afford *not* to use quality control?"

Discussion

James Bethel (N. C. State College): Do you get quality cost figures for each department or just overall?

Mr. Chateauneuf: The quality cost figures are obtained for each department and totaled per division and the whole factory. This cost figure includes all inspections (piecework, daywork and salary), all repairs plus the scrap (value at the operation scrapped) and also the fixed charges, such as annual holidays, and so forth, for all the people attached to the quality cost figure.

Vincent Ross (Draper Corp.): Are there other costs included, such as insurance?

Mr. Chateauneuf: Yes, the insurance benefit is one item of the fixed charges. It should also include all people connected to the maintenance of the quality, such as centralized inspection, laboratory quality test, and so forth, but not the money spent for the development work.

J. R. Stillinger (Cascades Plywood Corp.): Is every single cabinet inspected?

Mr. Chateauneuf: Yes, a 100 per cent piecework inspection for general appearance is made on each cabinet after it is completed.

Mr. Bethel: Referring to Chart 6, frequency distribution describing a process variation of a supplier. It looks more like your supplier took the defective ones out instead of correcting the process.

Mr. Chateauneuf: Oh, being aware of what we will not accept. We think the supplier corrected his process to give less variation. Otherwise, the 14 per cent defective parts shown would have been too excessive to live with. If the process of the vendor was not corrected, it is to his disadvantage, but our firm gets the part to the right specification, which is the protection we are after.

Mr. Ross: How do you arrive at the statistical control limits for the "P" Chart, Fig. 10?

Mr. Chateauneuf: On this chart we put arbitrary limits based on the assumption that there should not be more than one per cent defective. $\bar{P}$, (Process defective average) is called one per cent and the statistical control limits are calculated on that base.

Leonard E. Cumming (The Wurlitzer Co.): Do you have any figures to show the cost of statistical quality control and inspection relative to direct labor?

Mr. Chateauneuf: The cost will vary with what you are producing. The costs would be different in sawmill, a furniture factory of other type. In our case, the quality cost was 6.5 per cent of the total production value (direct labor with material plus overhead, excluding the packing) and is now 4.1 per cent. My opinion is that a range of 4 to 7 per cent could serve as a guide for a factory producing a moderately high quality of furniture from rough dimension precut stock.

Mr. Stillinger: If the sampling procedure on parts throughout the process is functioning effectively, then why do you need 100 per cent inspection of the finished product?

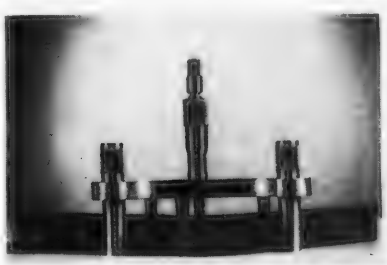

Fig. 11.—Measuring device for controlling

Mr. Chateauneuf: We do not want to take any chances with the finished product being defective. This 100 per cent inspection for general appearance is similar to a productive operation, it is done on piecework followed by a sampling, which rate the quality of the product and the performance of the inspector.

Mr. Stillinger: Are you taking any chances when previous inspections are made?

Mr. Chateauneuf: We are, because humans make mistakes. Operators are all on piecework. In any case, we feel we need a system to keep operators and inspectors on their toes. We are convinced that sampling does the job effectively and economically.

Stanley Shatwell (Singer Mfg. Co.): We are willing to accept up to four per cent defectives in processing up to the final product. Sampling plan tables allow for three to four per cent defective. We wish to make doubly sure that the imperfections on the final product will be put aside for correction before delivered to the shipping.

Harlan G. Freeman (The Wabash Screen Door Co.): Following that line of reasoning, you should have another 100 per cent inspection to make triply sure that no defective products reach the market.

Mr. Chateauneuf: It is true that you could continue to add 100 per cent inspections. In fact, we used to have a few day work 100 per cent inspections. We decided that there will be only one 100 per cent inspection on the finished goods (piecework) followed by a statistical quality control loose sampling inspection. We feel we are getting good results and more protection at less cost.

Status of Tungsten Carbide in the Woodworking Industry[1]

REX V. REYNOLDS

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Proper tungsten carbide applications should be engineered cooperatively by the user and the producer. Because of its hardness, rigidity, and wear resistance, tungsten carbide reduces maintenance costs in existing operations and makes possible machining operations that previously were not economical.

THE SUCCESSFUL ADVANCE OF CARBIDE knives and cutting tools is associated with the "new look" as worn by the woodworking industry. The "new look" stems from a desire for survival that causes the leaders in the woodworking industry to review methods, improve operational efficiency, study utilization of raw materials and many other associated research activities.

One of the important steps in accomplishing this "new look" has been, and will continue to be, the acceptance and use of tungsten carbide tools.

With the introduction of cemented carbide in the early thirties, woodworkers with progressive and inventive minds envisioned the new material as a possible miracle cutting tool. Many purchased the expensive tungsten carbide and did experimenting on their own. Some were successful, but most were doomed to failure.

The metal — cutting industry did likewise at approximately the same time, but the incidence of success was sufficient to warrant continued testing, and the closely knit machining industry soon made rapid strides in the application of these new carbide compositions. The woodworking industry now stands on the threshold of an equally great acceptance of this material. Tomorrow's success will be directly in proportion to the educational program that the woodworking and carbide industries are willing to adopt to provide sound application and design information to the actual users of the material.

There are four basic points to be considered in the application of tungsten carbide. A study of the tables on physical and mechanical properties (Tables 1 and 2) will assist in proving why these four points are basic:

1. Tungsten carbide is not of the steel family, and should not be treated as such. Try to effectively utilize its best properties when designing or adapting for your requirements.
2. Hardness, high rigidity, and wear resistance of tungsten carbide make possible the economic machining of wood and wood synthetics that heretofore has not

Fig. 1.—The exhaust hood has been removed from this planer to show one of the 50-inch carbide knives used in a hardboard surfacing operation.

[1] Presented at the Fall Meeting of the FPRS Northeast Section, held October 25-26, 1956, in New York, N. Y.

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Table 1.—MECHANICAL PROPERTIES

Material		Hardness test, Rockwell 60Kgs A	Hardness test, Rockwell 150 Kgs C*	Transverse rupture, psi Calculated Beam	Young's Modulus of Elasticity, psi Musical Pitch	Compressive strength, psi Crush Tests	Torsional strength shearing stress psi Min. Values Reported
Typical tungsten carbide	A	91.0	78.0	300,000	74,000,000	600,000	125,000
		19.5	79.0	250,000	72,100,000	585,000	100,000
		93.0	82.0	200,000	73,900,000	640,000	-------
	B	91.0	----	250,000	70,000,000	646,000	-------
		91.5	79.0	275,000	80,100,000	705,000	-------
		92.0	80.0	250,000	79,600,000	650,000	-------
	C	90.0	76.0	325,000	77,900,000	560,000	186,000
		90.5	----	300,000	----------	----------	-------
		92.0	80.0	250,000	94,300,000	800,000	-------
		92.5	81.0	200,000	90,600,000	675,000	-------
		93.0	----	175,000	83,000,000	746,000	-------
		91.5	79.0	250,000	82,300,000	617,000	-------
	D	90.0	76.0	275,000	65,500,000	663,000	-------
		91.0	78.0	300,000	74,000,000	600,000	125,000
		91.5	79.0	250,000	72,000,000	590,000	100,000
	E	85.0	67.0	360,000	61,600,000	518,000	-------
		86.5	70.0	380,000	64,400,000	539,800	-------
		87.5	71.5	385,000	71,900,000	572,000	-------
		90.0	76.0	325,000	77,900,000	600,000	186,000
		90.5	77.0	300,000	82,000,000	644,500	-------
		92.0	80.0	250,000	94,300,000	800,000	-------
Steel	HSS 18-4-1 Heat-treated	max. 85.0	max. 66.0	-------	32,500,000	600,000	-------
	1.10% C. Heat-treated	max. 83.0	max. 62.0	-------	29,500,000	-------	Est. 60,000 to 116,000
Co., Cr., W. Alloys		83.5 85.5	63 to 67	160,000	30,000,000	-------	-------
Brass 60-40 cold-drawn		86.7 B Scale		-------	15,000,000	20,400	-------

Table 2.—PHYSICAL PROPERTIES

Material		Specific gravity, gms/cc	Conductivity: Thermal cal/°C/cm/sec.	Conductivity: Electrical % of Copper Standard	Coeff. thermal expansion: x10-6/°F. Up to 1200°F.	Coeff. thermal expansion: x10-6/°C. Up to 650°C.	Magnetic permeability μ Induction
Typical tungsten carbides	A	11.90	.113	4.7	4.0	7.2	3.0
		11.10	.068	4.3	3.9	7.0	2.0
		11.50	.095	4.5	3.6	6.4	---
	B	12.65	.105	5.2	3.6	6.4	---
		12.90	.136	5.8	3.9	7.0	2.0
		12.45	.127	5.3	3.7	6.7	2.0
	C	14.10	.147	9.4	3.1	5.5	---
		14.40	----	---	---	---	---
		14.80	.170	7.8	2.5	4.5	1.5
		15.10	.191	5.0	2.5	4.5	---
		15.15	.114	5.3	2.7	5.1	---
		14.80	.207	8.0	2.8	5.0	---
	D	11.80	.081	5.1	3.5	6.2	---
		11.90	.113	4.7	4.0	7.2	3.0
		11.10	.068	4.3	3.9	7.0	2.0
	E	12.90	.106	8.7	3.9	7.1	---
		13.41	.182	10.0	3.9	7.1	---
		13.81	.110	9.2	3.4	6.1	---
		14.10	.147	9.4	3.1	5.5	---
		14.60	.156	8.7	3.3	5.9	---
		14.80	.170	7.8	2.5	4.5	1.5
Steel	HSS 18-4-1 Heat-treated	8.6	.061	3.0	7.0	12.6	---
	1.10% C. Heat-treated	7.8	.14 (est.)	----	8.2	14.7	150-50
Co., Cr., W. Alloys		8.38 to 8.76	Low	1.8	8.0 to 9.4	14.5 to 16.9	Very Low
Brass 60-40 cold-drawn		8.4	.20	----	11.6	22.1	1.0

been practical. Basic improvement of the product being machined is also possible when using tungsten carbide.

3. Learn and use the best methods of maintaining carbide tools. Diamond jointing and grinding are necessary for maximum performance. Use proper techniques at your plant, or set up a maintenance routine with a good service shop.
4. Co-operation between the carbide supplier and the user is paramount. To obtain the maximum results, a free flow of information regarding end use is necessary. Complete information is necessary for a carbide supplier to give recommendations regarding the best grade, most effective cutting angle, and other pertinent job assistance.

When applying carbide to the woodworking industry, it is not feasible or necessary to arbitarily junk all the existing woodworking machinery in order to take advantage of the many benefits offered by tungsten carbide. It is true that better efficiency can be had with new equipment, but an old machine, in good state of repair, can make an excellent showing with tungsten carbide.

The adaptation of solid tungsten carbide knives is one basic step that makes today's success possible in contrast to previous brazed carbide knife applications. During the past two years, the carbide industry has developed techniques by which high-quality solid carbide knives up to 72 inches in length have been successfully manufactured. The application of these knives has been most successful using conventional mechanical holding methods, the carbide knives are strain-free and give such outstanding performance as to make them economically attractive to practically all users of woodworking equipment.

There has been some contention in the past that carbide knives could not be successfully ground, jointed, or maintained in the field. It has also been claimed that the knives would not stand the abuse from lumber with loose knots, glue lines, or other normal production defects. The following actual operations should leave no doubt as to the application of solid carbide knives to the woodworking and associated industries.

A. Fifty-inch solid carbide knives jointed and ground with diamond wheels on planers with standard grinding equipment.
B. High-production mills planing with solid carbide knives at 650 feet per minute without damage to the knives.
C. Carbide knives jointed at 3600, 5400, and 7200 rpm.
D. Steel lag screws and nails purposely placed in lumber and planed without breakage or ill —effect upon the carbide knives.

Applications of Interest

Hardboard: In hardboard plants in Laurel, Mississippi; Portland, Oregon; Dee, Oregon; and elsewhere, steel knives were reasonably satisfactory on low-density fiber board, even with the necessary five hours per day of grinding and maintenance time. On a highy-density or tempered hard board, it was almost impossible to get acceptable finish or production. With the installation of a set of 50 by 1–½ by 5/32 inches solid carbide knives, the quality, finish, and production of all types of board were improved. The feed rate per minute was increased more than 50 per cent, the noise factor was greatly reduced, and the need for daily maintenance was no longer required—in fact, knife maintenance was practically eliminated. Many unseen factors such as metallurgical processing, rigidity, special

cutting angle, balance diameter, grinding, and jointing contributed to these successful operations. The open cooperation by the user and the carbide manufacturer helped in making these applications successful.

A recent report on one of the above installations indicates that less than 1/32 inch of carbide has been removed from the width of the blade in nearly two years of use. There has been over ten million square feet of hardboard surfaced with these knives. The cost per thousand feet for this planing operation has been reduced from one dollar, when high speed steel knives were used, to less than 16¢ per thousand with the carbide knives.

Scarfing Operations: At a laminated beam plant in Oregon, there is an application wherein tungsten carbide is used in scarfing the planking used in the fabrication of the large laminated trusses and beams. Prior to the adoption of tungsten carbide, this scarfing operation required 16 hours for approximately 5500 scarf cuts. With tungsten carbide, production has now increased to 8500 scarf cuts in 16 hours. This increase in production definitely justifies the use of tungsten carbide, to say nothing of the reduced maintenance.

Scarfing Plywood: A plywood mill in Washington is presently using two 16 by 1–¼ by 3/16 inch solid carbide knives that have run eight weeks on a plywood scarfing job. Steel knives previously used on this job required grinding after 40 hours. The carbide knives were run for an eight-week period and required no maintenance.

Furniture Manufacturing Finished Planing: One of the original applications for long, solid knives was in a North Carolina furniture plant on a finished planing operation. This plant has operated its planer with these knives for over 28 months with a minimum of maintenance. The knives have been reduced about 1/16 inch in width during this period.

Jointing Carbide

Jointing carbide with a diamond stone created a minor problem when it was first tried. This was overcome, however, and the answer is typical of problems encountered by carbide application engineers.

The unwritten law of jointing is to get an end result (a true cutting circle and a uniform land on each knife). The most effective jointing method is to use a diamond wheel on a conventional grinder, where a greater surface area of diamond is used for the jointing operation than can be obtained from a jointing stone. In this operation, the diamond wheel is run at 3600 rpm with the wheel rotating into the cutting edge of the knife. The head and knife assembly is also rotating at 3600, 5400, or 7200 rpm.

Jointing with a diamond stone presents some additional problems. It cannot be assumed that the speed of a cutter head has the same relationship to a fixed stone as a diamond grinding wheel does to a fixed work piece. Actually, the relationship is proportional to the rpm of the cutter head, its circumference, and the square-inch surface area of the jointing stone. For example, a 12-inch head has approximately three feet of circumference per revolution working against a 0.25 to 0.50 square inch area of jointing stone. At 3600 rpm, this is about 10,800 surface feet per minute. It is not uncommon to run a diamond wheel at 6000 surface feet per minute, 0.50 square inch work piece, but in this case the relationship is reversed. Therefore, on large planer heads it is not practical to joint at operating speeds with a diamond stone because of the high surface feet per minute. However, jointing can be effective and successful at a reduced rate that will give the diamond stone an opportunity to cut and clean. This is a situation common to all heads, but particularly true on the larger ones. Manufacturers should consider this problem when designing accessories or new equipment.

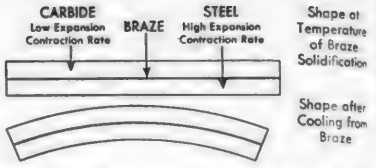

Fig. 2.—The difference in coefficient of expansion between tungsten carbide and steel.

Objections may be raised to the idea of jointing at speeds below the regular operating speed. While these objections are not entirely unfounded, it should be pointed out that the increased rigidity of the head containing tungsten carbide blades make the probability of spring out, or change of the operating plane, quite dissimilar from that which is expericened with steel blades in the same head. In the application on fiber board with the 50-inch blades, the deflection of the head on the high-density board was such that the machine vibrated excessively when steel blades were used. When the carbide blades were introduced, however, vibration was practically eliminated. It is normal practice to balance and install carbide knives to closer tolerances than are usually assocaited with high speed steel knives.

Knives are not the only application of tungsten carbide that is of interest to the woodworking industry. Parts that make use of its high degree of wear-resistance and corrosive-resistance are being applied successfully in pulp and paper mills. Debarking nozzles, pump sleeves, and band-saw guides are a few of these applications.

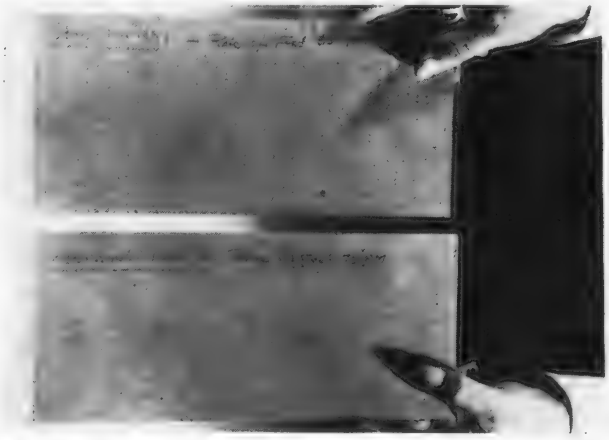

Fig. 3.—The upper piece of hardboard surfaced at 35 feet per minute with steel knives. The lower piece was surfaced at 70 feet per minute with jointed carbide knives.

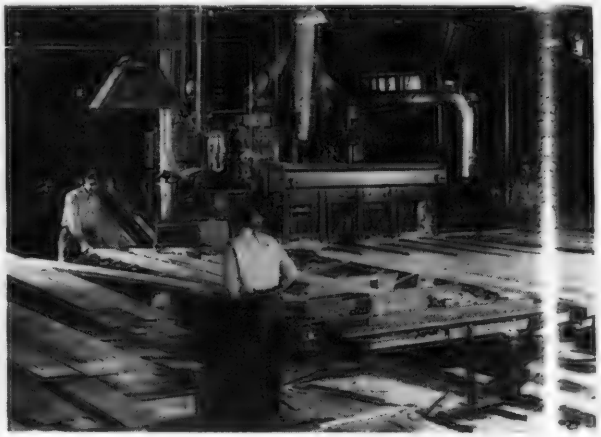

Fig. 4.—Downtime was significantly reduced in this laminating operation when carbide knives were used on the specially designed scarfer.

The Following Five Papers Were Presented at the Twelfth Annual Northwest Wood Products Clinic

Practical Production Analysis[1]

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Production analysis is essentially a balance of raw material entering a plant against finished goods and wastes leaving. A flow sheet of the operations performed on the raw material provides a valuable if not essential, tool for management.

TO SURVIVE IN TODAY'S BUSINESS CLIMATE one must not only know the details of his business, he must know them systematically, especially in the relations of each detail to every other detail, and each detail in relation to the entire operation. In no other way can one achieve and maintain the good perspective of his operation that is so vitally important.

By definition, a production analysis is a means of attaining this sort of perspective. It is one of the best available means to discover weak points and diagnose ills so that they may be strengthened and cured. A production analysis is also the best possible basis for determining where the plant can be improved, and for planning future production.

As in many other things, there are many degrees and types of production analyses. A complete analysis would include everything connected with the operation, such as raw materials supply and procurement, its variety, quality, quantity, and cost; plant and equipment; personnel; management; costs; markets and sales, and so on. The services of a number of specialists might be required to prepare such a complete analysis.

Let us presume that the very fundamental question of what the market wants that you can produce, together with how much, has been answered. Next to that answer, an analysis of the production facility itself is the most valuable single part of a complete analysis. It will yield more answers than any other one part, and besides it will reflect much light onto other parts of the total operation. This analysis is readily prepared by a trained man at a relativeley minor cost. As the keystone of a complete analysis it is a most effective management tool.

Successful managers have facts and figures of every detail of their operations available in their office. Most will find, however, that it is a difficult and time-consuming task to review and evaluate each set of information in relation to all the other sets. Also, most will find that, when they start reviewing critically these separate sets of information, each set has inconsistencies when compared with the others. It is often a considerable task to create consistency out of this inconsistent mass of information. This task is an important one, but it is seldom done until management decides to make a complete production or *flow process* analysis. A pictorial and graphical presentation that makes use of lines, directions, areas and colors is unexcelled for a quick and complete grasp, not merely of isolated details, but of the whole operation. A flow sheet is a picture in a very real sense, and is the most useful form of production analysis for most purposes.

The very name "flow sheet" suggests liquids, and as a matter of fact the flow sheet made its first appearance in the liquid processing industries of oil and chemicals. It was so successful there that it has since been applied to practically every other industry that produces goods and commodities on a continuous basis.

Nothing else can help one understand something new like a specific example. An example of the application of a flow sheet to a lumber operation is most appropriate here (Fig. 1).

The flow sheet is a simple tool, but it is a most effective means of presenting the clear picture needed for planning, control, cost accounting, changes, and reduction in cost of production. It is a primary tool in those industries which have shown the greatest reduction in production costs, and which have led the way to modern plants, adequate for their job and with the flexibility to meet market demands.

Lumber milling is just as much a process as is the making of steel, the refining of petroleum, or the manufacture of chemicals, autos or any other product. Material is received, various operations are performed on it, and it is shipped. Between processing operations, it is transported and stored. The same analysis used in planning, designing, revising, and operating chemical plants and petroleum refineries can be applied to lumber manufacture. The process industries have made extensive use of the flow sheet, and there is no reason why the lumber industry cannot benefit from its use in planning new mills, revising facilities, and supervising operations. In fact, several of the more progressive mills in the Northwest are now using this tool to analyze what they currently own and for planning improvements and expansions.

The flow chart of an existing mill before improvements, which is shown in Fig. 1, indicates briefly, quickly and clearly the production, manpower requirements, the flow of material, and other pertinent information. It gives a

[1] Presented at the 12th Annual Northwest Wood Products Clinic, held April 9, 1957, in Spokane, Wash.

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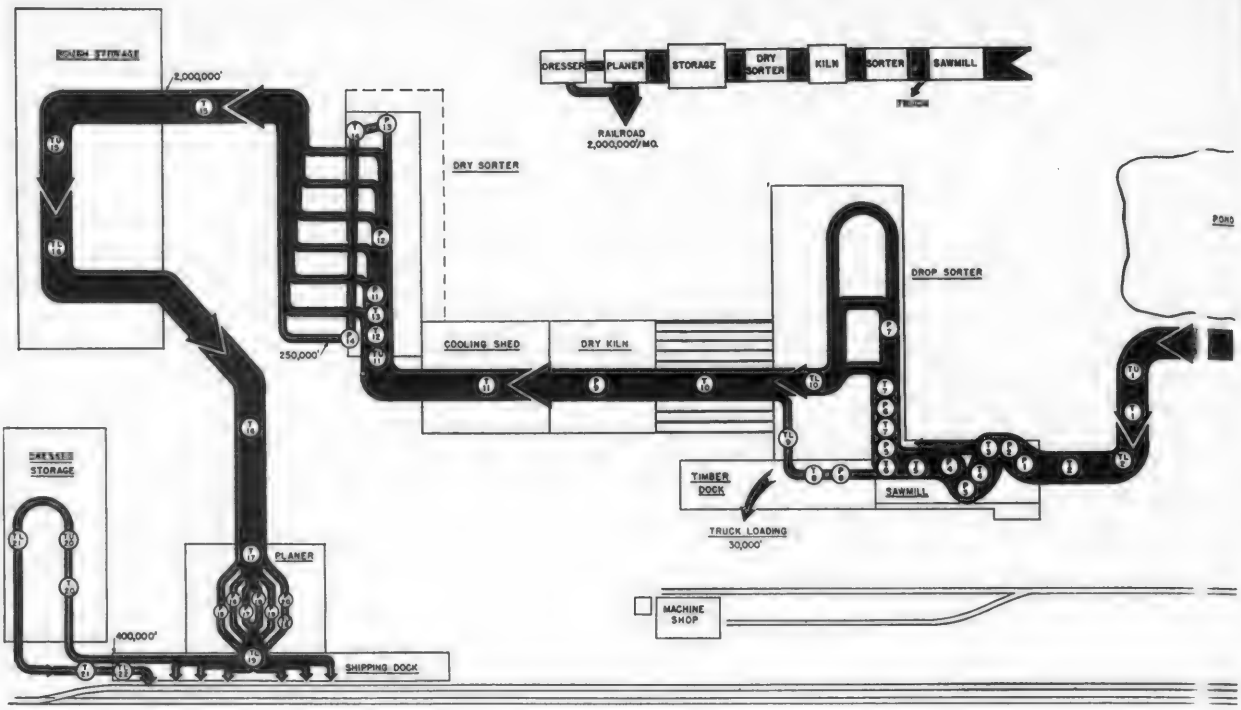
Richard Batdorf holds a BA degree from the State College of Washington. He had nearly 30 years of engineering experience with the U. S. Bureau of Reclamation, U. S. Bureau of Soils and Chemistry, U. S. Army, and the State College of Washington before joining Bovay in 1956.



LEGEND

- (P 1) PRODUCTION OPERATION No. 1, etc.
- (T 1) TRANSPORT OPERATION No. 1, etc.
- (TL 1) TRANSPORT LOADING OPERATION No. 1, etc.
- (TU 1) TRANSPORT UNLOADING OPERATION No. 1, etc.

NOTES

1. PRODUCTION FIGURES ARE FOR TWELVE MONTH AVERAGE, 1948
2. SAW MILL AND GREEN SORTER OPERATED TWO EIGHT HOUR SHIFTS
3. MANUFACTURING EMPLOYEES ARE CLASSIFIED AS FOLLOWS
   OFFICE AND SUPERVISION - - - - 5.7% PRODUCTION - - - - - 29.4%
   MACHINERY AND MAINTENANCE - 22.1% MATERIALS HANDLING - 42.8%

DRY SORTER AND PLANING MILL
one shift

(P 11)	GRADE LUMBER ON DRY SORTER	3
(P 12)	DRY SORTER PULL OFF (10 pull-off men, 1 relief)	11
(P 13)	REMANUFACTURE FOR UPGRADING (3 re-cut, 2 re-sort)	5
(P 14)	GRADE REMANUFACTURED LUMBER	1
(P 15) (P 16) (P 17) (P 18) (P 19) (P 20)	PLANING MILL OPERATION	
	ASSISTANT FOREMAN	1
	MACHINE FEEDERS	4
	GRADERS	5
	TRIM MEN	4
	TRADE NAME STAMPERS	4
	PRODUCTION - - - - - - - - -	38 MEN
(T 11)	TRANSFER CARS OUT OF KILN	1
(TU 11)	UNLOAD KILN CARS ONTO SORTER	2
(T 12)	RETURN STICKS TO GREEN SORTER	2
(T 13)	STRAIGHTEN LUMBER ON CONVEYOR	1
(T 14)	CART REMANUFACTURED LUMBER	1/2
(T 15)	CART LUMBER TO ROUGH STORAGE	2 1/2
(TU 15)	UNLOAD CARTS AND STACK LUMBER	17
(TL 16)	LOAD CARTS	13
(T 16)	CART LUMBER TO PLANER	3 1/2
(T 17)	PULL-IN MEN FOR PLANER	2
(T 18)	TIE UP PINE FLOORING WITH CORD	2
(TL 19)	LOAD R.R. CARS FROM PLANER	11
(T 20)	CART LUMBER TO DRESSED STORAGE	1/2
(TU 20)	UNLOAD CARTS AND STACK LUMBER	2
(TL 21)	LOAD CARTS	2
(T 21)	CART LUMBER TO SHIPPING DOCK	1
(TL 22)	LOAD R.R. CARS FROM DRESSED STORAGE	2
	MATERIAL HANDLING - - - - - - - - -	65 MEN

SAW MILL AND GREEN SORTER
two shift totals

(P 1)	SCALE LOGS AND UNLOAD CONVEYOR	2
(P 2)	BAND MILL	4
(P 3)	GANG SAW	4
(P 4)	EDGER	4
(P 5)	TRIMMER	2
(P 6)	GRADE LUMBER ON CONVEYOR	2
(P 7)	GREEN SORTER PULL-OFF	8
(P 8)	CHECK AND GRADE TIMBER	2
(P 9)	OPERATE KILNS AND TEST MOISTURE	2
	RELIEF	2
	PRODUCTION - - - - - - - -	33 MEN
(TU 1)	UNLOAD R.R. CARS & LOAD ON CONVEYOR	
(T 1)	LOG TRANSFER CHAIN (AUTOMATIC)	
(TL 2)	LOAD LOGS ON CONVEYOR	2
(T 2)	LOG CONVEYOR TO SAWMILL (AUTOMATIC)	
(T 3)	ALIGN LUMBER FROM BAND MILL	2
(T 4)	ALIGN LUMBER ON CROSS CONVEYOR	4
(T 5)	STRIP CATCHERS FOR HOG (4); HOG FEEDERS (2)	6
(T 6)	TRIM LOADERS	2
(T 7)	ALIGN LUMBER ON CONVEYOR TO SORTER	4
(T 8)	HANDLE TIMBER FOR CHECKER	2
(TL 9)	LOAD TIMBER ON KILN CARS	2
(TL 10)	STACK LUMBER ON KILN CARS AT SORTER	6
(T 10)	TRANSFER AND SWITCH CARS INTO KILN	3
	RELIEF	2
	MATERIAL HANDLING - - - - - - - - - -	1 MEN

Fig. 1.—Typical process flow existing in a mill before modernization.

clear picture of the operation that cannot be equaled by memory, by walking through the mill with its attendant distractions, or by any other method. The relations between the various functions of a plant are seldom clear to a person who may be making a tour through the plant, and it has been demonstrated over and over again that these same functions may not be clear to people who have been working in the mill for years, either.

A properly prepared flow sheet is equally useful to the novice who must grasp the over-all picture before he becomes a useful member of the organization; to the foreman who must know how his men must expend their efforts to best advantage; to the cost accountant who must keep management informed of production cost trends; to the engineer who plans changes to equipment or improvements in plant efficiency; and especially to management who must always be interested in increasing profit margins and meeting competition if the business is to be carried on successfully.

A flow chart is an over-all visible plan that can be analyzed to reduce the unit cost of the product manufactured and keep this unit cost low by making every operation of the plant contribute to this end. By first establishing the volume of production required, each operation can be balanced to get the required production with the least expenditure in machinery and labor. It has often been found that some operations may be eliminated entirely or be combined with other operations to induce savings after study of the flow chart.

If the flow chart is kept up to date and properly used, any executive can

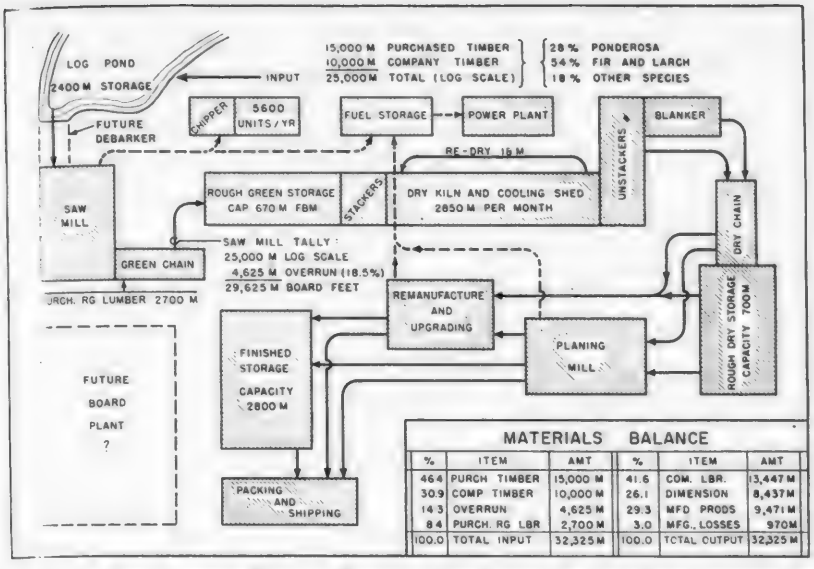

LOG POND
2400 M STORAGE
INPUT
15,000 M PURCHASED TIMBER
10,000 M COMPANY TIMBER
25,000 M TOTAL (LOG SCALE)
28 % PONDEROSA
54 % FIR AND LARCH
18 % OTHER SPECIES
FUTURE DEBARKER
CHIPPER
5600 UNITS/YR
FUEL STORAGE
POWER PLANT
UNSTACKERS
BLANKER
RE-DRY 15 M
SAW MILL
ROUGH GREEN STORAGE CAP. 670 M FBM
STACKERS
DRY KILN AND COOLING SHED 2850 M PER MONTH
DRY CHAIN
SAW MILL TALLY
25,000 M LOG SCALE
4,625 M OVERRUN (18.5%)
29,625 M BOARD FEET
GREEN CHAIN
JRCH. RG LUMBER 2700 M
REMANUFACTURE AND UPGRADING
PLANING MILL
ROUGH DRY STORAGE CAPACITY 700 M
FUTURE BOARD PLANT ?
FINISHED STORAGE CAPACITY 2800 M
PACKING AND SHIPPING
MATERIALS BALANCE
% ITEM AMT % ITEM AMT
46.4 PURCH TIMBER 15,000 M 41.6 COM. LBR. 13,447 M
30.9 COMP TIMBER 10,000 M 26.1 DIMENSION 8,437 M
14.3 OVERRUN 4,625 M 29.3 MFD PRODS 9,471 M
8.4 PURCH. RG LBR 2,700 M 3.0 MFG. LOSSES 970 M
100.0 TOTAL INPUT 32,325 M 100.0 TOTAL OUTPUT 32,325 M

Fig. 2.—A typical material balance. Everything that enters the plant must somehow be accounted for as it leaves.

keep in close touch with his milling operation, even if he is a thousand miles from the mill. Knowing the conditions to be met at any given time, any intelligent man can glance at the flow sheet of his operation and quickly interpolate on it the effect of any change in the operation. It gives him a quick, positive picture and makes it unnecessary for him to walk through the mill to stay familiar with its operations, and precludes the quite possible chance that he will forget some of the things he saw because of distractions.

As proof that this is possible, some of the largest manufacturers whose superintendents seldom have time to visit the plants often have the lowest production cost. In other words, they have no choice but to keep up with operations by intelligent use of work sheets and of good data. Because they can concentrate on this rather than having to walk around the plant continuously, they can arrive at sound judgments based on facts and figures rather than on conclusions that are colored by prejudices.

The flow sheet in Fig. 1 is necessarily a simple one. However, it does show most of the fundamental elements that make up a good flow sheet. These are:

1. The flow of all materials and products are plotted to the same scale so that the operations can be visually analyzed.

2. Every operation, even the relatively minor ones, should be shown. Often a profitable operation can be created out of a non-profitable one when proper decisions are made concerning the whole.

Each man is itemized in a manner so that his type of work is readily apparent. In lumber-mill work, this is usually broken down to at least differentiating between supervisory, production, and material-handling personnel. It may also be necessary to show maintenance personnel separately.

4. Each man is located geometrically at his proper place in the mill.

As mentioned earlier, a great deal of work is often required to obtain consistency from the inconsistent sets of information that are available for making up the flow sheet. For some operators, the creation of a consistent set of facts pertaining to their operation may be the most important result of the study. Many examples are known where a chaotic production situation existed merely because one portion of the mill was basing its work on figures that were inconsistent with the figures used in another portion of the plant.

Before the flow sheet can be made, a complete material balance of the mill must be made. This material balance must be just as rigorous as is a heat and weight balance for a power boiler installation. Everything that enters the plant must be accounted for, in one way or another, as it leaves. A simple example of such a material balance is presented in Fig. 2.

For the larger mills, it is usually important to elaborate on the material balance and make a separate waste balance for the mill. This waste balance can be used to point up unnecessary losses. It can also be used as the basis for determining whether or not "waste user" plants (such as hardboard plants) should be established.

The flow chart, of course, is merely a visual summary of the plant's operation, and of a more detailed *general flow* and *process study* of the mill. The general process study will elaborate in some detail on all the elements that make up the flow sheet. For instance, for a lumber mill the following are usually included:

1. The various features of the mill are described in detail, from the log supply to the shipping facilities.

2. The many sorts handled by the mill are itemized and analyzed as to their advantages and disadvantages. Such an analysis may lead to simplifying the sorting procedure, and it may lead to the introduction of mechanical sorting equipment.

3. An analysis of the material-handling procedures is made. Any material handling is an expense only. It does not contribute anything to production. Also, it can create losses through degrade of product. Very often, some of the largest potential savings in any lumber mill are through savings in manpower required for the many material-handling procedures.

4. An analysis of the various storage facilities is made.

5. The safety and fire protection elements are analyzed.

6. The production requirements as related to the sales program are analyzed.

7. The mill's operating schedules as related to production requirements and necessary maintenance are analyzed.

8. Kiln schedules as related to production and storage may be analyzed. A recent kiln operation review resulted in increasing production from existing equipment by almost 20 per cent. And this increase came from a company that publicly prided itself on its kiln operations.

9. A special analysis of all low-grade production as related to existing and proposed mill procedure may be valuable.

10. A written description of the duties and requirements of every job in the mill is important. When each job is described and then located on the flow sheet, it is often clear where some jobs can be eliminated or combined with others.

After a general flow and process study has been made of an existing mill, then it is possible to make intelligent decisions about how to best operate that mill. If the mill is of any size at all, such a study is absolutely essential before embarking on any sizeable modernization program. Reasons for a modernizing program include the following:

1. Greater equipment efficiency.
2. Greater manpower efficiency.
3. Increased production.
4. Lower production costs.
5. Upgrading products.
6. Achieving a more "balanced" operation.

7. Providing an opportunity to make all operations more consistent with each other. This will eliminate many mistakes because of having to make so many production choices in a short period of time.
8. Greater plant flexibility.
9. Better production control.
10. Decreased maintenance.
11. Improved sales position.
12. Maintained or improved company competitive position.
13. Increased net profits.

These reasons are all related, but are so diverse in nature that it is only by means of such study that complete and consistent answers can be found.

Now, what is the best procedure to follow in preparing a general flow and process study for your operation? Conceivably, any intelligent and informed person can prepare such an analysis. If he is a member of the organization concerned, however, he is apt to be handicapped by something less than complete objectivity. Experience shows that his prejudices for or against certain phases of the operation may handicap his ability to present a complete and unbiased picture. Once the initial study has been prepared, company personnel can keep it up to date. However, the initial study is usually best prepared by an outside firm specially trained for work of this nature in many industries. Such a firm is not only in a better position to visualize the operation without preconceived ideas and attitudes, but it can also contribute a great deal through its experiences with and ideas gained from other industries that have somewhat similar, even though unrelated, problems. A flow and process study is no better than the care used in its preparation. Because of its final simplicity, it can be entirely misleading if prepared and analyzed by inexperienced groups. It is usually best, therefore, to utilize the services of a qualified professional consultant for work of this nature.

A General Flow and Process Study, together with its accompanying flow sheets, can be a most valuable tool for analyzing current problems and for planning changes to an existing facility. For the larger mills with their complex array of integrated plants it is more than a tool. It is an essential element of good management procedures. All lumber mills, however, once they are of the size that more than one management mind must be used for making the various production decisions, should have this tool working for them. The professional consultant is a good, unbiased source for obtaining this tool. However, if qualified men are available to make such a study, they should be used. The tool is too important, and will yield too high a return to be neglected.

Delayed-Memory Programming[1]

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Present applications of delayed-memory programming are outlined, with a brief description of how the programming is organized to reduce personnel costs. Further possibilities and limitations of delayed-memory programming are discussed.

A DEFINITION OF DELAYED-MEMORY PROGRAMMING that will cover all of the implications is hard to work out. Perhaps the simplest is to say that it is a means of controlling given functions, co-ordinated to occur at pre-determined times and places, as established in the programming device.

The purpose of this description will be to direct thinking toward the simplicity, rather than the complexity, of devices designed to sort out, delay, and finally cause functioning in certain operations.

There are many things in our daily lives that are ordered by delayed-memory programming. The alarm clock, for instance, is a *time delay* memory control. The more modern ovens may be triggered through a double time delay to go on at a given hour and off at another. This is advance programming, and it can be *cancelled out* by turning a switch.

A considerably more complex application of delayed-memory programming is the "juke box", which receives coins of different denominations from several sources, remembers the order in which they were received, and remembers which side of each record is to be played. The juke box is analogous to programming in lumber manufacture, where in effect we are dropping in coins that will predetermine what will happen.

The term "cancelling out" was used earlier. It is important in programming for lumber operations that we be able to do this. A record in the juke box is always the same, whereas a board may change length, or grade, or you may want to change the width, or some exception to a rule is made. Remember, this is not a purely automatic operation where certain things happen because a limit switch or some such device is triggered here and there.

As a simple example of programming, suppose that we want to sort all lumber coming from a sawmill to thickness and length only, for kiln stacking. We are not concerned about how the boards get off the chain, whether by mechanical Swede, or drop gates, or other methods. We are concerned about the program that will cause these events to happen at the right time.

First, we set up in the memory device a series of switches that say "four-quarter go here; five-quarter go there", and so on. Then a second series of switches are set up to say "10-foot go here, 16-foot go there, and 12-foot there", and so on for the lengths. Then an "area of memory" is established in relation to the point of function. In this case, the area may be ahead of the sawmill trimmer, and the saws are keyed into the control so that the lengths are determined at that point. This area of memory is also an area of control, and this is where the

[1] Presented at the 12th Annual Northwest Wood Products Clinic, held April 9, 1957, in Spokane, Wash.

[2] At the time the paper was presented, Mr. Green was with the Irvington Machine Works of Spokane.

ability to cancel is important. Suppose that all the lumber is now flowing to the points set up in the program, and you decide that the four-quarter number five common should go to the yard for air drying, or that you do not want 10 foot 2 by 4's in the kilns. The operator simply touches a key that overrides the program for that particular board only, and we have accomplished an exception to the rule as set up.

To show specifically what can be done, a few actual installations will be described.

There is now an installation in British Columbia that is controlling the flow of lumber through a sawmill trimmer, wherein lumber is programmed to pre-determined destinations. This mill ships green surfaced dimension, and their program works something like this. The planer is to run a car of 2 by 6's, 10 to 20 feet long. A belt conveyor runs from a drop-through gate in the green chain immediately behind the trimmer to a storage chain leading to the feed table of the planer. The control system takes over before the trimmer, and directs all 2 by 6's of the desired lengths to the planer, automatically rejecting the other lengths. If only Douglas-fir is desired for the planer and some other species come along, the operator touches a button and that piece is rejected. Other lumber coming from the sawmill is programmed to other places. Timbers, for instance, are not programmed and simply go on to the end of the chain, and are disposed of there. That is one example of programming, and certainly not an elaborate one. The changeover to another program is simply a matter of turning button switches.

An application in a planing mill may be seen at the Clearwater unit of Potlatch Forests, Inc., at Lewiston, Idaho. Here the lumber passes from a grading table to an automatic feeder, which feeds an automatic smooth-end trimmer. As a board leaves the feeder, it enters a memory zone where any of the programmed operations may be changed. Here the operations programmed include trim or not trim; print or not print, and sorting to certain points. Most of these functions are automatic and are controlled by the characteristic of the board itself, because a memory-delay program has been set up in the system. The program can be changed instantly, and any one phase can be cancelled by the operator.

There is no limit to the number of operations than can be controlled by these systems, although there are limitations on types of equipment to be controlled. We can control mechanical Swedes, gates, jump rolls, jump chains, kickers, saws, printers, and so on. Combinations of these can be used to get lumber to stackers, planers, and factories, or into units. There is room for improvement in devices covering this field, but the devices themselves can be automatically controlled in a pre-determined and scheduled manner by a delayed-memory program.

A form of delayed-memory programming is found in many sawmills where the riderless carriage is used, and it is fairly certain that the sorting and handling of lumber from the edger to the stackers and from the kilns to the planers is a great field for delayed-memory programming.

Automation of production is making a cautious entry into a number of industries. The lumber industry, by the nature of its product, is a hard one in which to see chances for true automation. The first step is the ability to program, and that first cautious step has been taken. The steps to follow must be equally cautious, but there are sometimes some obvious steps that can be taken boldly. Such was the case with the mill in British Columbia, where the problem was comparatively simple, and the savings large.

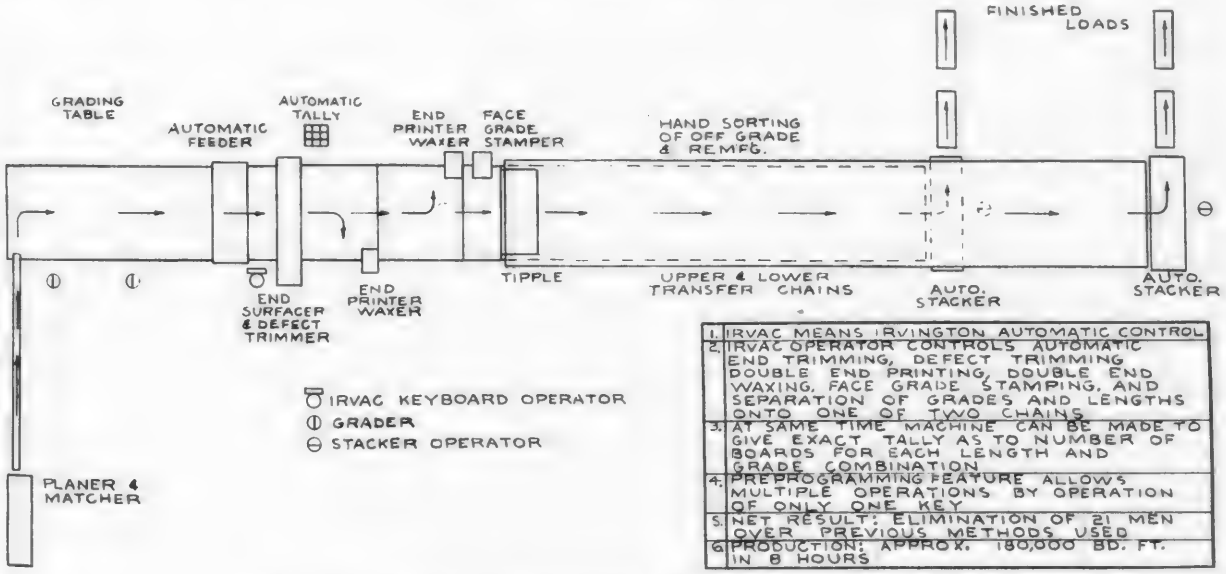
FINISHED LOADS
GRADING TABLE
AUTOMATIC FEEDER
AUTOMATIC TALLY
END PRINTER MARKER
FACE GRADE STAMPER
HAND SORTING OF OFF GRADE & REMFG.
END SURFACER & DEFECT TRIMMER
END PRINTER MARKER
TIPPLE
UPPER & LOWER TRANSFER CHAINS
AUTO. STACKER
AUTO. STACKER
IRVAC KEYBOARD OPERATOR
GRADER
STACKER OPERATOR
PLANER & MATCHER
1. IRVAC MEANS IRVINGTON AUTOMATIC CONTROL
2. IRVAC OPERATOR CONTROLS AUTOMATIC END TRIMMING, DEFECT TRIMMING DOUBLE END PRINTING, DOUBLE END WAXING, FACE GRADE STAMPING, AND SEPARATION OF GRADES AND LENGTHS ONTO ONE OF TWO CHAINS
3. AT SAME TIME MACHINE CAN BE MADE TO GIVE EXACT TALLY AS TO NUMBER OF BOARDS FOR EACH LENGTH AND GRADE COMBINATION
4. PREPROGRAMMING FEATURE ALLOWS MULTIPLE OPERATIONS BY OPERATION OF ONLY ONE KEY
5. NET RESULT: ELIMINATION OF 21 MEN OVER PREVIOUS METHODS USED
6. PRODUCTION: APPROX. 180,000 BD. FT. IN 8 HOURS

Fig. 1.—The delayed-memory programming flow chart at Potlatch Forests, Inc.

Veneer and Lumber Void Filler[1]

B. L. CARLSON

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A combination of phenolic resin, catalyst, and filler is blended to form a viscous paste that can be used for continuous patching. Quality and durability of the patched area are high.

THE FOREST PRODUCTS INDUSTRY is constantly being forced to utilize lower and lower grades of logs for the manufacture of veneer and lumber. This results in a decidedly smaller amount of clear veneer or select-grade lumber. We are therefore faced with the task of utilizing lower grade veneers in plywood, and then upgrading it through the use of patching materials and overlays of very thin veneers, plastic, or paper. The lower grades of lumber may also have their defects, such as knot holes, pitch pockets, or worm holes, repaired to present the smooth, solid surface desired.

The patching processes of the plywood industry previously employed have not been entirely suitable to automation of application. A void-filling material has been developed that lends itself to continuous patching. Some patching processes previously developed have not been entirely satisfactory, due to shrinkage of the patching material upon drying or curing, and poor mechineability of the patch itself.

The void-filling material consists of a special phenolic resin and catalyst that are blended together with fillers, such as bark, asbestos, or clay. The mixing of the patching compound may be varied to conform to special needs, but a typical formulation is as follows:

Amres 1960	100 parts by weight
A-M 1960 Catalyst	25
	Mix 3–5 Minutes
Silvacon 509	20
	Mix 3–5 Minutes
Asbestos, Iron Free	60
	Mix 5 Minutes

This mix results in a viscous paste, quite suitable for spreading, which has a useable life of four to eight hours.

This paste is applied to the surface of plywood that has knot holes, checks, splits, or other roughness, with the defects being filled and the surface scraped off level with the surrounding area by the doctor blade of the application machinery, as shown in Fig. 1.

The general process in the production of overlaid plywood is: First, to rout out the knothole of the face veneer just beyond the glue line, because best bonds are obtained by eliminating the old, cured glue line. Second, apply the patching compound, cure by hot platen, and sand the surface. Third, apply overlay and cure in hot press to form a bond through the latent glue line. There are many possible variations to the above procedure.

The upgrading of lumber may also be accomplished with this patching compound. Chief concern has been with one-inch lumber in studies up to this time.

Dr. John Krier of the Montana State University gave an excellent paper at the previous Wood Products Clinic on the causes of degrades of lumber, and also actual data on the amount of degrade to be expected in the mill. Effects noted as contributing to loss of grade were: loose knots, knot-wood break, live-knot breakout, sloughed knots, split-cracked live knots, planer-torn grain, and saw-torn grain. These defects which cause over 20 per cent of the degrades, are repairable with the void filler described. Of course, the patching compound does not make perfectly clear lumber, but most of the degrade can be upgraded to smooth-paint-grade lumber.

The method of repair will naturally vary with the type of defect encountered and also the frequency of appearance. Complete voids, such as knotholes, will take somewhat longer to cure than will an area of saw-torn grain that is less than ⅛ inch deep.

With regard to the cost of the usage of this material, one cubic inch of the material (filling by volume, not weight) including 20 per cent waste, thermo energy required for cure application machinery and labor, estimated on an automatic process, would be about 6 to 8 mils. Mr. Hugo Schmidt of the J. Neils Lumber Co. reported, at the last Wood Products Clinic, knot frequency up to ten knots of 1¼ inch diameter in lumber 4 by 12 inches by 16 feet long. Based on this rate, the cost per thousand board feet would be about 4 to 5 dollars. Smaller defects on the surface only would be considerably less in cost per thousand board feet.

The finished product has shown excellent weather resistance. The paintability of the product with lacquer, varnishes, oleo-resinous, and vinyl coatings is quite satisfactory and should be treated as the surrounding wood. The void filler itself may be dyed to simulate knotty pine knots. The material may be nailed, sawn, planed, and so forth, to meet the carpenter's requirements.

In summary, the advantages of this system of upgrading plywood and lumber are that, through automation, manufacturing costs are cut and the reclamation of rejected items may be economically accomplished. The quality and durability of the patched area are of the highest standards.

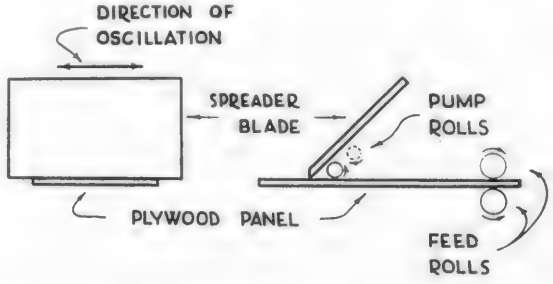

Fig. 1.—Schematic drawing of patching compound spreader.

[1] Presented at the 12th Annual Northwest Wood Products Clinic, held April 9, 1957, in Spokane, Wash.

The Author: Bayard Carlson graduated from the University of Nebraska with a degree in chemistry. He worked on the development of new coatings for General Paint Corp. before he joined American-Marietta's special products department of the Adhesive, Resin, and Chemical Division.

Carbide Wood Cutting Tools[1]

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The development of the applications of carbide for woodworking tools is described. Advantages and limitations are discussed in relation to the various present applications and possible future uses.

MATERIALS USED IN WOOD CUTTING TOOLS have changed considerably in the last 40 years.

Going back in history for a moment, we find that saws and planer knives were made of essentially the same type of material—about a 1 per cent carbon steel.

During World War I, high speed steel was developed and used extensively in the metal-working industry. Shortly after the war, it began to find its place in wood working. It will not take as keen an edge as a carbon steel, but it will stay sharp longer. It was this characteristic of high speed steel that made it more acceptable in the planing mill. There were some problems in its use, but they were not difficult to overcome. The same sharpening equipment could generally be used. The men used the same technique for grinding as with carbon steel. They used a grinding wheel of a little different grade, but aside from that the care and maintenance was identical.

In the late '20's and early '30's, on the West Coast particularly, a material commonly known as high carbon—high chrome steel was introduced in the planing mills. It found a wide acceptance because it had a high abrasion resistance and would hold an edge better than high speed steel when planing soft woods. And once again, the switch to this new material was an easy transition.

During the second World War, the government restricted the amount of tungsten that could be used in steel. The knife manufacturers had to turn to a different analysis of high speed steel that would stay within the government restriction and still do the job that was necessary in the planing mill. As a result, what is known as M-2 type high speed steel was used extensively. It proved to be superior for wood working in most cases, and today most knife manufacturers use this type steel where use of a high speed steel is indicated.

Since World War II there has been a great deal of experimenting by the knife manufacturers to find a higher quality wood working knife. When we say higher quality, we are thinking both of edge-holding characteristics and the keenness of the edge. As mentioned earlier, the keenest edge can still be obtained with a carbon steel; this point is important because it is here that we encounter one of the problems with carbides.

Most woodworking plant operators would, if asked, say that they are using carbides. But are they using them in all the places they should? Probably not, because they and their suppliers do not as yet understand all the things that can be done with carbides. It might be well to take a look at some very basic things about carbide tools. Some people refer to them as a new type of steel—this is not correct. Carbides are tungsten carbide, tantalum carbide, or titanium carbide in most cases. They are a powdered material that has been mixed with a binder and formed into a cutting tool. Probably the best analogy that we can draw would be the mixing of concrete. If you want good concrete you put in gravel, sand, and cement in the proper proportions. If proportions are incorrect, you do not have the wear or strength characteristics that you might expect. The same is true of carbides.

One of the more common mixtures is 94 per cent tungsten carbide and 6 per cent cobalt binder. Each of the various manufacturers of carbides uses this and other combinations, but they are all essentially the same. They have some properties that should be of interest. We think of them as being hard, and they are. If we were to measure their hardness on the Rockwell C scale, which is not the way it is done but is done here to give a comparison, we would find a hardness of 66 to 70. A woodworking planer knife is about 60 Rockwell C, while saws are in the range of 40 to 50 Rockwell C. You can see that the average hardness of carbides is not a great deal more than that of tools commonly in use. But by the above method we are measuring the mixture and not the hardness of the individual tungsten carbide particles, which are much harder than the mixture.

Tungsten carbide has many characteristics that are beneficial and some that are detrimental, particularly to the manufacture of tools. Carbides give the hardness that is needed, but at the same time it gives a brittleness. This brittleness creates one of the biggest training problems in the use of carbides. Operators have to be taught that any carbide tool must be treated more carefully than the conventional steel tool that it replaces. Carbide has a high compressive strength, and is generally thought to have a low tensile strength. It does have a very high modulus of elasticity, and in some applications, particularly on planers with 50-inch-long knives, the high modulus of elasticity has been of benefit because it stiffens the cutter head. Thus there is less deflection and a more accurate cut than when steel knives are used.

The above remarks might make one think that carbides and their uses were something new: they are not. Carbides were developed in Germany during World War I, and the General Electric Company was licensed in 1928 to produce them in the United States. The first woodworking applications of tungsten carbide were made almost 30 years ago—1929 to be exact. The Fischer Body Co. used an extensive amount of carbide in 1929 and 1930 on the wood parts than used in automobile bodies. The application of carbide was held back by high prices and the depression, and it was not until after World War II that carbide applications were made in sizable numbers in the woodworking field. The most satisfactory applications have been where manufacturers had trouble with conventional steel tools. The use of carbide expanded more rapidly in the East in the manufacturing plant than it has in the West in the sawmill and planing mill.

Design Problems

There are some design problems in applying carbide to woodworking tools. Veneer knives with an included

[1] Presented at the 12th Annual Northwest Wood Products Clinic, held April 9, 1957, in Spokane, Wash.

The Author: Kenneth Duff graduated from the University of Washington in chemical engineering. He has been employed as an engineer with Disston since 1941.

angle of 22° or 23° are not a good application, because carbide must have at least a 45° included angle for best results. In the application of carbide to saws, fewer teeth are used in many cases because it is necessary to have more space for a brazed-on carbide tip than what would be required for a conventional tooth. Fewer teeth have not been the problem that it might appear to be. Carbide saws in most cases are made more accurately, and in almost all cases the alignment of the sides of the teeth is much closer. Also, the use of saws with two or three teeth on one side to one on the other has maintained the quality of cut with fewer total number of teeth. This has been particularly true on plywood skinner and cut-off saws or zero saws on trimmers.

Most plants have tried carbide tools, and where they have had good results have expanded the applications. Those that have had poor results on the first application have in many cases decided they were not practical and have not made use of carbides in places that they should. Carbides are not a cure-all any more than is any other material. But they do have place, and if a plant is cutting abrasive materials such as glue lines on plywood, paint lines on softboards, or hardboards with binders that have abrasive characteristics, then carbides should be considered. Some of the imported mahoganies that have a high percentage of silicates in the wood are good applications.

The maintenance of carbide tools creates some problems, but they are not so great as they might first appear. The high cost of diamond grinding wheels, approximately $250 each, has been a deterrent to some plants that do their own sharpening. Also, the grinding machines have to be in first class shape and in some cases special machines are necessary. Even with the above problems, most mills prefer to do their own maintenance. For those who do not, however, there are several other plans available. Most carbide- tool suppliers are very willing to do resharpening and retipping. There are also rental plans in effect that do away with the maintenance problem.

Regardless of how the tool is to be resharpened, it is most important that it not be run after being damaged or run excessively dull. The cost per unit cut mounts rapidly as a carbide tool reaches the point of maximum life between resharpenings. Experience has shown that, if the tool is resharpened at about 80 per cent of maximum life, the most economical operation will be obtained. The calculation of this is of course difficult, but it is one that every plant should seek to determine.

Carbides, like everything else, are going to have some failures. We should not let these failures discourage us but rather strive to find the reasons for the failure and do things to overcome the problem. Improper applications of course are the cause of some failures, but with the use of carbides being relatively new in our industry we have not had too many in this category.

Grinding cracks are probably one of the more common difficulties. Carbides are difficult to grind—they must be ground slowly, and in most cases removal of approximately a thousandth of an inch at a pass is the maximum. Training in the proper technique is necessary for everyone who is to grind carbide. Braze failures are another source of trouble, but they are being reduced by better materials and methods. The condition of the machine on which a carbide tool is to be used is very important. It must be free of vibration and in as near perfect condition as possible. In running carbide-tipped saws, collars as large as the work will permit should be used to get the best results. One of the surest ways of reducing failures of carbides is to have all personnel who come in contact with carbide cutters trained as to what it will do and how it should be cared for.

Results You Can Expect

What kind of results can you expect from carbide tools in woodworking? They are going to last longer than steel—how much longer depends on the application. There are records where carbide has lasted up to 300 times longer than steel. That is an exceptional case, but the average is 20 to 50 times as long. If it gives 50 times the life of a steel saw, for instance, you have accomplished three things. It only has to be sharpened 1/50 as often, and it does not cost 50 times as much to sharpen. In addition, you have had better quality sawing. The original quality of cut will not be quite up to that of a conventional cutter, but as it becomes worn, the carbide saw will give better quality on the average than will the worn steel saw.

The third saving is in the amount of down time. A good example of down time saving is a mill that was machining Apitong, which is very abrasive. With conventional cutters they could run only 15 minutes between sharpenings. With carbide cutters they are able to run an eight-hour shift between sharpenings. Just the saving in down time will quickly pay for installation of carbide in this situation.

Carbide knives have not been used as generally as saws—to date most applications have been on particle board or on hardwood. There are relatively few being used on the West Coast in planing mill operations. The reason for the popularity of carbides in the softboard industry is the filler or paint, which is abrasive, used on most of this type product. There probably is not a plant manufacturing softboard that is not using carbide-tipped cutters.

The wood industry was slow in getting started in the use of solid carbide knives. The metal-working industry had been using bolted-on carbide inserts for several years before it became popular in the woodworking industry. The brazing of carbide tips on knives limited the length of knife that could be made, and greatly restricted the applications on planing.

Solid carbide knives have been used very successfully on many applications, but as yet their use on fast-feed planers has not been a success. Several tests have been run, but in most cases they have failed because of the inability to "joint" the knives. The most successful way to "joint" or grind carbide knives while in the cutter head is with a diamond hone or a diamond wheel. Crystolon stones are not satisfactory because they wear away too rapidly and a straight joint is not obtained. The diamond hone will not remove very much material, and therefore the knives have to be trailed very accurately.

The most successful jointing of carbide knives has been done with a diamond wheel mounted over the knife while it is in place in the cylinder. The diamond wheel is then traversed along the knife in the same manner as a jointing stone. One machine manufacturer makes an attachment that fits their machine to do this, and most of the successful operations of carbide knives have been on their machines.

One of the other problems of solid carbide knives is chance of damage to the knives. Solid carbide knives are expensive—$100 or more per knife is not unusual. The chance of damage because of striking foreign material is always present, and there has been some concern over breakage. Breaks in solid carbide knives can now be repaired. It costs approximately one-half the new knife price and gives satisfactory results.

Future Materials

Looking to the future, what are some of the materials or variations of present materials that may be used in woodworking? Sprayed tungsten carbide may find greater application particularly if the cost can be reduced. It does not have all the properties of cemented tungsten carbide but its wear

characteristics are good. Another possibility is tungsten carbide combined with powdered metal. One man has spent a lot of time on this, particularly in regard to application on chipper knives. This is one of the tougher applications and success here would mean a lot to the woodworking people.

Still another new approach is the use of tantalum carbide with steel instead of cobalt as the binder. It will not be quite as hard as tungsten carbide, but it has some terrific advantages. Instead of the tool manufacturer receiving a material that is so hard that it must be ground or cut by an electrical discharge method, he would receive a material approximately the hardness of a steel saw. This is not so hard but what it can be machined by conventional methods and then heat-treated to get the desired hardness. This would be the answer to formed knives, which at the present time are difficult and expensive to make with cemented tungsten carbide.

Another material type that is in the day-dreaming stage is ceramics. The metal-working industry in the last few years has made great progress in ceramic tools. They are getting finer finish and higher speeds, and it is within the realm of possibility that it can be used in woodworking. Several of the manufacturers of ceramic tips have stated they do not feel it is feasible for woodworking, but when their literature is examined it is amazing to see that the things which are a detriment to the use of ceramics are exactly the same ones that were detriments to the use of tungsten carbides.

Many people feel that the woodworking industry has not done much to improve its tools. When one stops to consider that we are on our third or fourth kind of material in 40 years, however, it is realized that progress has been made. More changes are on the horizon and will likely come into use in the future. Economics will play a great part in the development of new tools. As labor and material become more expensive, greater amounts can and will be spent to provide tools that will do the job better and more quickly.

Discussion

C. J. Warren (Intermountain Lumber Co.): How about barker scraper tools. Would you recommend carbide tools there?

Mr. Duff: In barking operations?

Mr. Warren: Yes.

Mr. Duff: Well, when I first got into this business, one of the big production items of all knife manufacturers was these nice hollowed out knives for barking. Most barking was done mechanically. As you know, most barking today is done hydraulically. And it seems to be the way to do it. If you are barking mechanically, I would say it was a poor application, although somebody here may be doing it. But foreign material is hard on carbide due to its brittleness. And you are more apt to get foreign material in bark than in any other place that I know of. I also understand that it is abrasive.

Anon.: How about in the sawmill? Do you recommend carbide saws in the edger or in the band saw?

Mr. Duff: Carbide saws on the band saws—as I have said—is being done. There are some problems on it. At the present time, my analysis of it is that it is not economically feasible on a head saw. Most of the applications of carbide to band saws have been on resaws where they have an abrasion problem. Resawing of plywood, for instance, or something of that nature. Edger saws—it depends on what kind of material you are running through.

Anon.: Suppose you are just making ordinary lumber—no glue line, no paint, anything of that sort. No abrasives. You don't feel it is feasible at this point?

Mr. Duff: In most cases the economics have it licked.

Anon.: What about in the planer mill? You say not on high-speed planers. How high speed do you mean?

Mr. Duff: Well, wherever you have to have multiple knives cutting—in other words, in your plant you are probably running 10- or 12-knife equipment and you have to have 10 or 12 knives cutting or you are not going to get satisfactory lumber. That means jointing, and when you have to joint, our present knowledge indicates that it is not feasible unless you have problems. We have run tests and know that it can be jointed. It is difficult. In most cases you will not have lost time in a planing mill due to changing knives. You will change at the noon hour or after the shift so that it makes it a rather tough thing to justify carbide.

Anon.: How about the zero saw on the smooth-end trimmer?

Mr. Duff: I think it has an application, particularly where you have people who don't alternate their saws. If you put a saw on and leave it on a zero saw, which is poor practice, then carbide would be the thing to put on. We have had some problems there—this business of the included angle means that we cannot put on as keen a tool as we can on a steel saw. And that sometimes becomes a problem, depending on the quality of cut.

Anon.: Well, the quality of the cut would be adequate, would it not, for a waxing and end-printing proposition?

Mr. Duff: I believe so. We have them operating—not just us—but a lot of our competitors over there.

Anon.: You would say that the average cut—that is from beginning to end—is better than the average non carbide?

Mr. Duff: Yes.

Anon.: As a member of the same concern as you are, I would like to mention a personal rule of thumb. When I sell a carbide, never sell carbide where a steel saw will do the job. And I don't have any returns that way. Lots of times I could sell a carbide saw, but with a 50 per cent return, where does the manufacturer come out? Sure it might do a wonderful job for a little while, then eventually you get the return and then you are up against a problem.

Mr. Patronsky (Pack River Tree Farms Products): I was previously with Wabash Screen Door in Minneapolis. We had an application in Minneapolis in a straight line rip saw in which steel saws were being used. The saws had to be changed every six to eight hours. The superintendent of the plant felt that the steel saws were doing the job so there was no need for carbide application. However, when we tried the first saw, we used a 30-tooth carbide-tipped rip saw, and it operated for several hundred hours. Then we thought we would try further economy, reduce the number of teeth to 14, and that saw operated for again several hundred hours without change through knotty material at over 100 feet a minute, and that proved very definitely to be an economy over steel saws that were doing the job.

Anon.: Apologies, sir, there are always exceptions.

Reese Stoffson (Downer Lumber): I would like to ask the question whether or not we are limited in peripheral velocities on the saw, due to carbide inserts. Does it cut down on the perifial speed allowable by making insert teeth?

Mr. Duff: When you say "the perifial speed allowable", what do you consider the allowable for steel saws first, because there is a wide diversity of opinion on that.

Mr. Stoffson: I don't believe 12,000 is suitable speed, 10,000 probably, or 9,500.

Mr. Duff: We would put a carbide saw on that without any hestitation. I think every manufacturer would.

David Brown: Are there any differences in power consumption for carbide saws and conventional steel saws?

Mr. Duff: Yes, there are, although in most cases they are not serious. I don't know of any woodworking application that has had to back away from them because of any increase in power consumption, but there is some increase in power consumption in carbide over steel. Now one way that we lick it is what Mr. Patronsky had to say, reduce the number of teeth from 30 to 14. That's nothing new to carbide—that is a standard saw mill trick—when you get the problem of short horsepower, cut down the number of teeth and you can reduce your power requirements very rapidly.

Merits of Riderless vs Setter-Operated Carriages[1]

E. O. WALTERS
Research Engineer, Western Pine Association, Portland, Ore.

Data on five riderless and five setter-operated setworks showed little difference in accuracy or production, although riderless carriages showed increases when they replaced slower setter-operated setworks. Savings resulted from eliminating labor.

MANY ASSOCIATION MEMBERS have raised questions on the relative merits of riderless vs setter-operated carriages. Advocates of riderless equipment claim the sawyer is able to obtain increased production because all operations can be better co-ordinated when done by the sawyer only. Without a setter, faster return movement of the carriage is said possible. Greater accuracy in setting is claimed by eliminating the chance of human error.

Objections to riderless carriages most commonly heard are that the sawyer cannot perform both the duties of the setter and his former duties without loss of efficiency. Often heard is the statement that riderless carriage setworks are not as accurate as mechanical stop Trout-type setworks, and that they set different on large and small logs. Many feel they are fine for mills that saw small logs, but are not so satisfactory for sawing larger logs.

Mills that have changed to riderless carriages have reported break-in periods of from 7 days to 3 months to equal previous production. Some mills report no appreciable difference in production was noted, while others have obtained substantial production increases.

The Western Pine Association Research Laboratory has undertaken a study to determine the comparative setting accuracy and productive capacity of riderless and setter operated carriages. Other equally important objectives of this study are to obtain basic production data, not generally available, on various combinations of headrig equipment, the effect of log size and species on production, and factors that affect sawing accuracy.

Obtaining Production Data

Production and accuracy data were obtained on five riderless carriages. Three of these were double-cut and two were single-cut headrigs. The same data was obtained on five setter-operated carriages. Three of these were also double-cut and two were single-cut headrigs.

Obtaining comparable data between mills equipped with different types of equipment is difficult because of the many variables involved. Even with perfectly matched equipment, there are differences of personnel involved. Making before and after studies in the same mill, though it would eliminate differences due to personnel, has the disadvantage that equipment being replaced is frequently outmoded and not comparable to newer setter-operated

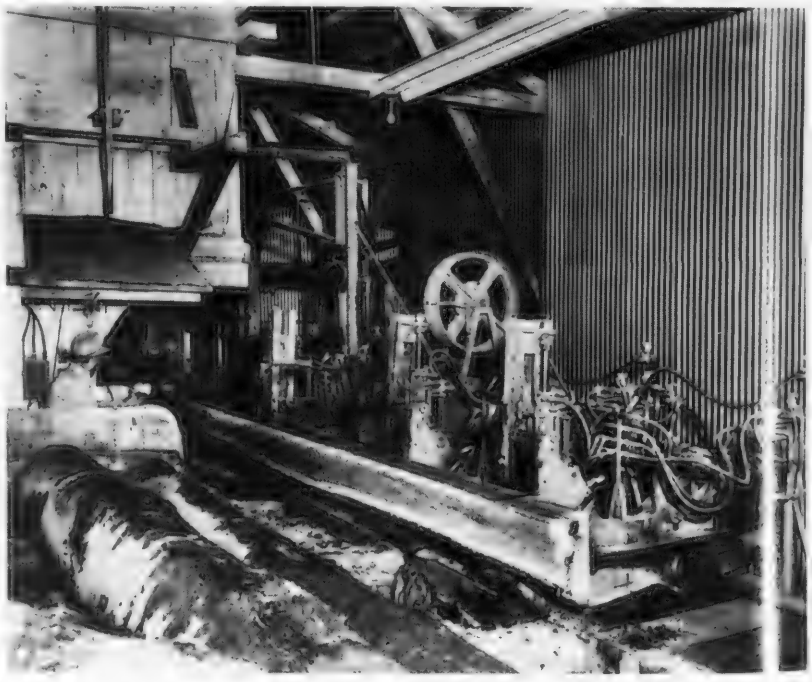


Fig. 1.—"Selectric" 7½ hp medium-duty setworks installed on Wheland All Air Carriage at Miller & Co., Birmingham, Ala.

[1] Presented at the 12th Annual Northwest Wood Products Clinic, held April 9, 1957, in Spokane, Wash.

The Author: Earl Walters graduated from Oregon State College with a BS degree in forest products. After six years of experience with sawmill and plywood operations, he joined the Western Pine Assoc. Research Laboratory in 1955.

Fig. 2.—Mater "42" riderless carriage in a hardwood operation at Oval Wood Dish Co., Typper Lake, N. Y.

Fig. 3.—Mater riderless carriage installed at Potlatch Forest, Potlatch, Idaho.

installations. Studies were made in mills equipped with the newest equipment available of both types. By taking time studies, it is possible to obtain comparable data even though mills have different sawing requirements and breakdown equipment.

To obtain the time required by the sawyer to perform each operation in sawing, the following method was used. A decimal time-study watch was used, and times were recorded to the nearest 1/100 of a minute. A log was timed in the following manner. The watch was started when the log loader was activated, and the elapsed time at the end or beginning of each operation was recorded. The watch was allowed to run continuously until the loader for the next log was activated. Gross scale and species were obtained for each log.

All unavoidable delay time is omitted from these times, and there is no allowance for down time. Unavoidable delay time includes: 1) stoppage of the headrig because of a plug-up at the back end of the mill, 2) time required to change setters or sawyers, 3) time required to change saws, 4) time carriage was down to remove rocks or foreign material with a hard ax, and 5) time to check accuracy of setting. Delays due to other causes are included in these times. These include: 1) time required to reset after a wind cut, 2) time to remove bark or debris from knees, and 3) time to redog in loading or turning.

For double-cut headrigs, the sawing sequence was divided into the following operations:

1. Load Log—elapsed time from activation of loader until carriage moved toward saw.
   Setout slab—elapsed time from time carriage started forward after loading log or completing a turn until saw entered log.
3. Saw slabs—elapsed time saw was in slab cut.
4. Set and saw—elapsed time to set out and saw each line.
5. Return time (divided into return after sawing a forward line and return after sawing a return line)—elapsed time from completing a saw cut to return to log deck to make a turn or load next log.
6. Turn—elapsed time from completing a return until carriage started forward.

The time sequence for single-cut headrigs was the same, except the time to set out each line was included in the time to return between lines.

Comparison of Production Capacity Of Mills Equipped With Riderless And Setter Operated Carriages

Time study data obtained were analyzed in the following manner:

The average time for each operation for each sawyer was determined by 5-inch log diameter groups (5 to 9 inches, 10 to 14 inches, and so forth). It was then possible to make a comparison between sawyers of their average times for each operation, based on the same size logs. This data also permitted a comparison of the effect of log size upon average times. Because average times for operations studied increase slowly as log diameter increases, this method does give realistic data on average operation time.

A study of this data showed the following:

Effect on Sawing Operations: Operations that directly affect the time spent in sawing varied but little between sawyers of mills with comparable equipment, either riderless or setter-operated. The operations to be termed sawing operations include time to saw lines, time to setout lines (other than slab lines), and time to return between lines. Though some of these operations do not directly involve sawing as such, they do directly effect the total time spent in sawing lines by various types of headrigs.

A comparison of average times for these sawing operations between comparable riderless and setter-operated mills showed:

1. No appreciable difference in speed of sawing when bandmills are comparable.
2. No difference in time to return between lines between headrig of each type. Single-cut headrigs do have faster carriage return times than do double-cut headrigs.
3. Certain riderless and setter-operated setworks were faster than ratchet-type and others, because of mechanical efficiency of setworks. The fastest riderless and setter-operated setworks were setting out lines at the same rate, however.

Effect on Non-Sawing Operations: These operations include the handling operations of loading log, setout slab, return (to turn or load next log) and turn. Average times for these operations did vary between sawyers of comparable mills. Some of this variation is expected and due to differences in proficiency between sawyers. A comparison of average times for these non-sawing operations for sawyers of riderless mills to sawyers of comparable setter-operated mills showed:

1. Sawyers of riderless carriages with five and six weeks of experience were taking appreciably longer to setout slabs. This operation includes time to get on the board rule when a sawn face is placed against the knee. Smaller increases in return and turn time were apparent.

Table 1.—COMPARISON OF TOTAL TIME FOR NON-SAWING OPERATIONS[1]

Mills compared	Range of diameter (inches)	Avg. gross log scale Bd. ft.	Species cut	Time in operation riderless	Total non-sawing operation time, min.		% difference in non-saw operations	
					Riderless	Setter	Increase	Decrease
D3-D5	9-31	165	ES	6 months	39.79	42.55	----	6.5
D3-D6	9-31	165	ES	6 months	39.79	45.07	----	11.7
D3-D4	9-31	165	ES	6 months	39.79	32.00	24.3	
D5-D3	6-39	390	PP	6 months	29.10	26.52	9.8	
D6-D3	6-39	390	PP	6 months	29.10	30.54	----	4.7
S4-D3	10-34	290	PP	6 months	42.29	29.08	45.4	
D1-D4	6-27	105	F&L	8 months	40.69	40.11	1.4	----
D2d-D4	7-25	150	WF	5 weeks	34.21	29.19	17.2	----
D2d-D4	7-25	105	ES	5 weeks	19.18	18.39	4.3	
S1d-S3	6-39	250	PP	6 weeks	41.12	35.55	15.7	
S1n-S3	6-39	270	PP	6 weeks	71.37	57.78	23.5	

[1]Between comparable riderless and setter-operated carriages.

load log, setout slab, return (to turn or load), and turn between comparable riderless and setter-operated carriages.

2. Sawyers of riderless carriages with six and eight months were performing these operations as fast or slightly faster on logs up to 20 to 24 inches in diameter, but were equal to, or slightly slower, on logs over 20 to 24 inches in diameter. This trend to a decrease in relative efficiency on larger logs compared to small logs did not appreciably effect over-all production, because differences are small and tend to counteract each other.

The effect of differences noted in non-sawing operations on total time to perform the non-sawing operations for sawyers with varying degree of experience on logs of various average size is given in Table 1. The total times for non-sawing operations were determined for each sawyer, as if each had performed the same number of non-sawing operations on logs of the size shown, from their average times for these operations. The number of operations used was the number performed by the sawyer of the mill listed first in each comparison.

The data in Table 1 does agree with reports of mills that, in two to three months, sawyers of riderless carriages are capable of the same or slightly increased production. Sawyers of riderless carriages with five and six weeks of experience, though slower in certain non-sawing operations, were obtaining a reasonable rate of production because the time for non-sawing operations constitutes only a small percentage of total over-all time (from 16 to 35 per cent for mills in this study.) Variations were due to differences in equipment and average log size.

The effect on total over-all time of the differences noted in total time for non-sawing operations and differences in board feet cut per hour are given in Table 2. The total over-all time was determined by adding the total time for non-sawing operations for both sawyers to the total sawing time determined by time study for the mill numbered first in each comparison when headrigs of the same type were compared. Where comparison is made between a double-cut and a single-cut headrig, the faster carriage movement found in single-cut carriages does effect sawing time and total over-all time.

The difference in time to set lines due to difference in mechanical efficiency between setworks noted earlier has a definite bearing on the experience a mill can have in converting to a riderless carriage. Differences in over-all time in the second table showed the difference possible when mills were comparable in setworks.

Mill D-3 was taking 12.2 per cent less over-all time than mill D-6 to saw Engelmann spruce logs averaging 165 bd. ft. in gross scale when differences due to setworks are included in over-all times. Records of this mill show the riderless carriage D-3 was equalling the cut for the setter-operated carriage, D-6, in 7 days. At the time of this study, six months later, mill D-3 was cutting logs of the size noted at a rate 1,200 gross bd. ft. per hour faster. Mill D-1 was taking 4.9 per cent less over-all time than mill D-4 when difference due to setworks was included.

Mills will experience considerable difference in production obtained and break-in time upon conversion to a riderless carriage. Variation will depend upon equipment replaced, speed of adjustment of the sawyer to riderless equipment, type of mill, and average log size. Some mills with older-type setworks can gain appreciably in production and will have short break-in periods to equal previous production. Mills with setworks comparable in speed to riderless setworks will have longer break-in times and may expect no appreciable difference or only small increases in production.

Comparative Setting Accuracy Of Riderless and Setter-Operated Setworks

To determine the setting accuracy of various types of setworks and the effect of other factors on accuracy such as saw deviation and carriage deviation, the following procedure was used. Measures on 4/4 boards were

Table 2.—DIFFERENCE IN OVER-ALL TIME FOR ALL OPERATIONS AND GROSS FOOTAGE CUT PER HOUR[1]

Mills compared	Avg. gross log scale Bd. ft.	Time in operation riderless	Total over-all time in minutes		% Difference over-all time, Riderless-Setter		Difference gross ftg. Hr. gd. ft.
			Riderless	Setter	Increase	Decrease	
D3-D5	165	6 months	125.52	128.28	-	2.2	215
D3-D6	165	6 months	125.52	130.80	-	4.0	4[illegible]
D3-S4	165	6 months	125.52	117.66	6.7	-	680
D5-D3	390	6 months	117.04	114.46	2.3	-	255
D6-D3	390	6 months	117.04	118.48	-	1.2	140
S4-D3	290	6 months	161.62	131.01	23.4	-	2150
D1-D4	105	8 months	136.47	135.89	0.4	-	20
D2d-D4	150	5 weeks	89.87	84.55	5.9	-	455
D2d-D4	105	5 weeks	53.29	52.59	1.5	-	110
S1d-S3	250	6 weeks	234.01	228.44	2.4	-	140
S1n-S3	270	6 weeks	355.30	341.71	4.0	-	245

[1]Between comparable riderless and setter operated carriages.

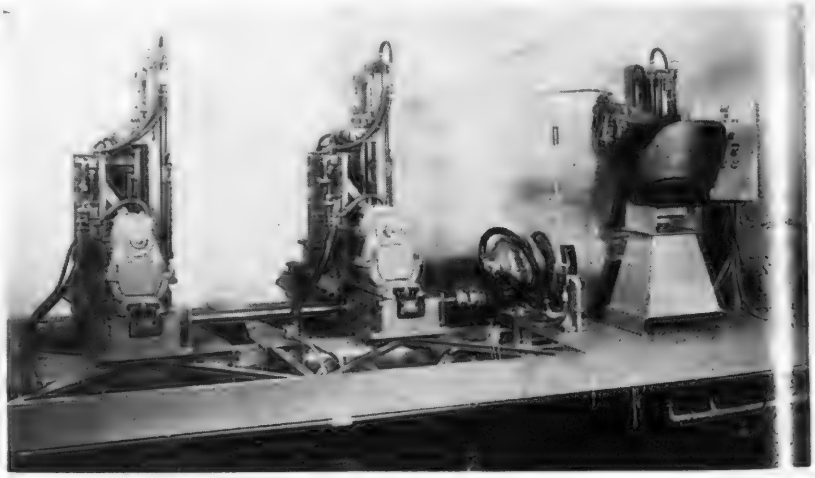
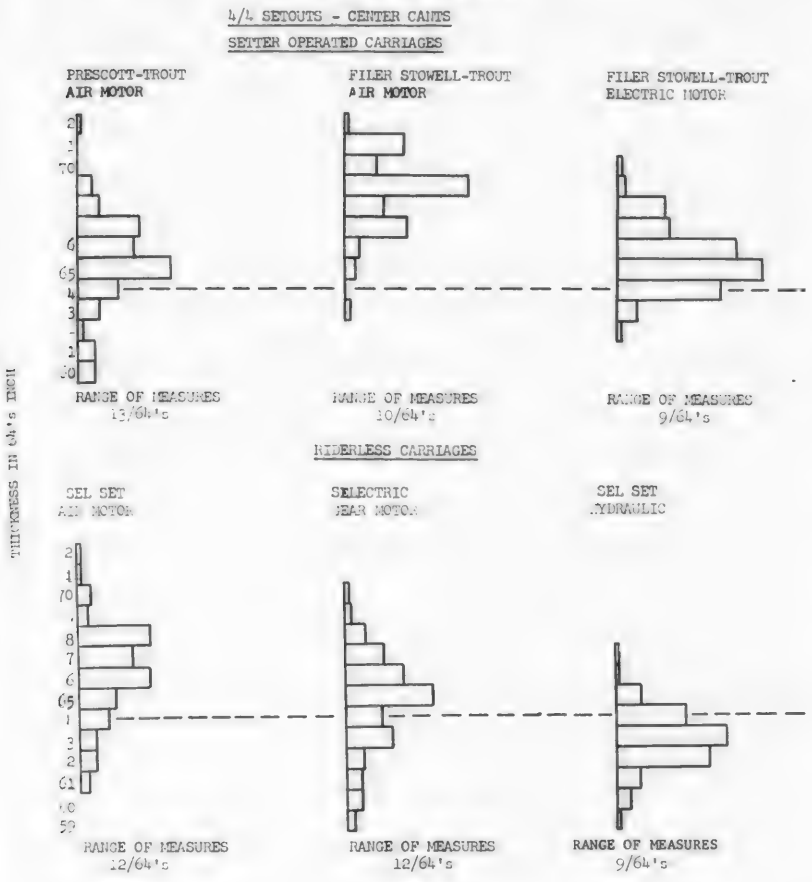


Fig. 4.—Prescott setter-operated air-motor setworks at Shearer Lumber Products, Elk City, Idaho.

Table 3.—COMPARATIVE SETTING ACCURACY OF SETTERMAN AND RIDERLESS SETWORKS



taken at four locations, top and bottom, to the nearest 1/64 inch with a slide caliper. Position I was one inch from the end of the board where the saw first entered the cut. Position II was two and one-half feet from the front end. Position III was two and one-half feet from the end of the cut, and Position IV was one inch from where the saw left the cut.

On double-cut headrigs, measures were taken for both directions of cut on 4/4 boards cut consecutively from center cants in all but one mill. On single-cut headrigs, measures were taken on 4/4 boards cut consecutively from center cants and 4/4 roundup cuts from the outside of larger logs. This was done to determine whether size or weight of material affected the setting variation of riderless carriages more than that of setter-operated carriages.

No dog boards, or first boards from cants, were measured. It is generally considered that stock cut from center cants will show greater variation than that cut from other portions of the log. Mills were being compared on an equal basis because measures were on the same type of stock. The average thickness setting for a setworks must be determined from its worst setting variation and not its best, so variation based on center cants is the most realistic and useful measure.

Table 3 shows the variation in setting accuracy for three setter operated and three riderless setworks. These setworks represent types most commonly in use, and were from mills showing the best overall control in setting and sawing. Although these charts show the thickness variation of combined top and bottom measures at only one measuring position, they are representative of thickness variation found at nearly all measuring positions. Only one mill in this study was sawing in perfect control for one direction of cut. That is, cutting the same average thickness at all points measured, and having the same variation in thickness measures at all points measured. All others showed varying degrees of lack of control because of saw deviation in the cut or carriage deviation at some measuring positions.

Riderless carriage setworks are capable of setting as accurately as setter-operated setworks now in use. The hydraulic Sel Set setworks was the most accurate of the riderless setworks checked. Make and type setworks, setworks power, speed of sawing, and mill maintenance have more bearing on accuracy obtainable than if a setworks is riderless or setter operated. The hydraulic Sel Set setworks included in this study was later removed by this mill because it was not as accurate as the setworks it replaced, and did not meet the standards required by the mill. It was accurate enough to exceed the degree of accuracy most mills studied were obtaining.

Summary

Mills equipped with riderless carriages are obtaining production equal to that of comparable mills equipped with setter-operated equipment. Substantial increases in production are possible when a riderless setworks replaces a slower, setter-operated setworks. Riderless setworks were just as accurate as the setter-operated setworks studied. A riderless carriage does result in considerable savings in labor by eliminating one man from the headrig. The price differential between setter-operated and riderless equipment or for conversion to riderless equipment is approximately equal to the possible savings in labor per year when used on a two-shift basis.

Abstracts From Current World Literature

Paints

Exterior House Paint. *American Zinc Institute,* 60 E. 42nd St., New York 17, N. Y., 1957, 60 pp, free.

A symposium presented by a panel representing the American Zinc Institute reprinted from the Sept. 1957 Official Digest of Federation of Paint and Varnish Production Clubs. Papers deal with paint blistering and the use of special exterior house paint primers; evaluation of low luster house paints; a review of standard house paints with regard to quality; and a panel discussion. [BRI Abstracts, March 1958]

Wood Chemistry

Felicetta, Vincent F., and McCarthy, Joseph L. Lignin. IX. Molecular weights of lignin sulfonates as influenced by certain acidic conditions. J. Am. Chem. Soc. 79, no. 16:4499–4502 (Aug. 20, 1957).

Delignification of hemlockwood by sodium bisulfite-sulfurous acid was carried out by the "incremental" method with five solutions of different acidity (pH 4.8, 4.8, 3.4, 2.51, and 2.09). About one third of the lignin was removed from wood under weakly acidic conditions; the average molecular weight (I) of this fraction was about 3000. Increasingly acidic solutions are required to remove the remaining lignin. That removed at pH 2.5 and 2.1 had (I) of 30,000 and 20,000, respectively. After further heating of each of the solutions in a more acidic medium the (I) decreased; the (I) for the five preparations after hydrolysis, i.e., for nearly the total lignin of the wood as about 6000. Similar results were obtained when purified nondialyzable lignin sulfonates were hydrolyzed in bisulfite-sulfurous acid and hydrochloric acid solutions. The (I) decreased progressively and approached a limiting value of 12,000. Lignins hydrolyzed to this limiting degree may be designated as "ω-lignins." Condensation seemed to occur simultaneously with hydrolysis, but more slowly. [Bul. Pap. Chem. V. 28, No. 2]

Husemann, E., and Spingler, E. The influence of oxygen on the hydrolytic decomposition of cellulose. *Makromol. Chem.* 24, no. 1:79–82 (July, 1957). [In German]

The action of acids on cellulose leads not only to an increase of reducing groups but also to the formation of new acid groups at the beginning of the reaction. This effect cannot be attributed to the opening of lactone rings or to the saponification of esters, since the exclusion of oxygen inhibits it completely. Hence it must be due to an oxidation mechanism. The oxidation does not occur inside the cellulose molecule but must be connected with a molecule-splitting process: the viscosity decreases faster in air than under conditions excluding oxygen. These results indicate that the periodic weak sites in the cellulose molecule differ chemically, not just morphologically, from the remaining glucose-chain linkages. [Bul. Pap. Chem. V. 28, No. 2]

Barkers

Stewart, Harry A. Log barkers of the rotatory abrading head type. U. S. patent 2,799,304. Filed Aug. 22, 1955. Issued July 16, 1957. 2 claims. [Cl. 144–208] M. 801.

In a barker for logs of short length and small diameter, the logs are fed vertically through the apparatus, the abrading unit is mounted in a horizontal plane, the abrading heads are held in operative position by centrifugal force, and the driving means permits barking of the areas around knots or projections without transmitting undue shock to the machine. [Bul. Pap. Chem. V. 28, No. 2]

Finishing

Delhees, D., Glein, G. and Kuhn, J. Behaviour of two component systems in the electrostatic field. Proceedings of 4th Fatipec Congress, Lucerne Verlag P. G. Keller-Winterthur 1957, pp. 165–169.

The application of reactive varnishes with a short pot-life is often difficult. A new method has been developed consisting of an electrostatic sprayer, called 'Ransburgh' 11. The two components of the varnish are fed separately and mixed only at the moment of spraying. Epoxy, isocyanate and unsaturated polyester resins can be applied by this method. Special surface effects may thus be obtained. (In German, Eng. abst.) [F. D. C. Tech. Bul. V. 7, No. 38]

Engelmann, H. R. Various applications of clear and pigmented polyester-coatings on wood and other substrates. Proceedings of the 4th Fatipec Congress, Lucerne Verlag P. G. Keller-Winterthur 1957 pp. 65–69.

The first part of this paper discusses the different possibilities of lacquer application systems, especially the two principles of the premixing chamber and application by pouring. The second part deals with some film properties of clear and pigmented polyester coating systems which are of particular interest concerning hardiness, adhesion and through-hardening and their practical results. Also, detailed information is given on the preparation of various surfaces such as different kinds of wood, metal etc., and the influence of this on the applied polyester coating. Sanding, rubbing and polishing of the coating itself are also specifically mentioned. [F. D. C. Tech. Bul. V. 7, No. 38]

Prefabrication

Hinchliffe, E. D. The Way Ahead For the Fabricator. *The Modular Quarterly,* 22 Buckingham St., London, W.C.2, England, Summer 1957, pp. 19–32, single copies, $1.00.

Paper deals with the natural economies offered by the engineering approach to the shop manufacture of components. It also discusses the problems and difficulties encountered in component construction. Examples of steel frame construction and curtain wall construction planned on 8′ 3″ or 3′ 4″ grids are given and illustrated with photographs of school and industrial buildings constructed by the author's firm (Hills, Ltd.). A list of 8 "Signposts for the Future" are also included to guide manufacturers of components in the production of units suitable for modular construction. [BRI Abstracts, March 1958]

Packaging

Anon. Folding carton annual meeting. Fibre Containers and Paperboard Mill 42, no. 4:105–10, 112, 114, 116, 118, 120, 123, 126, 128, 130, 132, 134, 136 (April, 1957).

Summaries are given of some of the addresses presented at the annual meeting of the Folding Paper Box Association of America, held March 31 to April 3, 1957 at Chicago. Authors and subjects included the following: Greenway, Norman F. President's report, p. 105–7; Johnson, [illegible]no. Blueprint for tomorrow indicates folding carton growth, p. 108–9; Rideout, George M. The business outlook, p. 110; Gates, James E. Innovation needed to make carton industry grow, p. 118, 120; Caddoo, [illegible]m. H. Bright horizon for cylinder boxboard (*cf.* B.I.P.C. 27:1089), p. 123, 126; and [illegible]eff, Robert C. Statistics—guidepost for [illegible]anning. [Bul. Pap. Chem. V. 28, No. 2

The preparation of abstracts from world literature in many languages is so highly specialized and costly that the Forest Products Research Society has no abstracting service of its own. For the abstracts in this issue of the JOURNAL the Society is indebted to the respective abstract journals indicated, from which they have been selected with the kind permission of the editors. Readers wishing information in addition to that given in these abstracts should consult the original articles referred to. Copies or additional information can not be supplied by FPRS or the abstract journal. The journals from which abstracts are published in this issue are as follows:

BRI ABSTRACTS OF BUILDING SCIENCE PUBLICATIONS, published for the use of its members, by the Building Research Institute, National Academy of Sciences—National Research Council, 2101 Constitution Avenue, Washington 25, D. C. Over 70 periodicals are reviewed, plus new books and research reports from industrial, governmental, and academic laboratories and organizations.

BULLETIN OF THE INSTITUTE OF PAPER CHEMISTRY, published monthly at Appleton, Wisconsin by the Institute of Paper Chemistry, subscription price $25 per year. This Bulletin publishes over 3,600 abstracts per year on subjects of interest to manufacturers of pulp, paper, fiberboard and allied products.

CHEMICAL ABSTRACTS, published semimonthly by the American Chemical Society, Executive Office—1155 Sixteenth Street, NW, Washington 6, D. C., subscription price $60 per year plus postage. This abstract journal publishes many thousands of abstracts annually with broad coverage of world literature in the entire field of chemistry and allied subjects.

TECHNICAL BULLETIN OF THE FURNITURE DEVELOPMENT COUNCIL is published bimonthly by the Council at 11 Adelphi Terrace, London W. C. 2, England. The Technical Bulletin publishes hundreds of abstracts and reviews from world literature annually, relating to the various phases of the furniture manufacturing industry. Subscription price is $5 per year.

Around the World in Forest Products Research and Development

The Philippine Forest Products Research Institute

EUGENIO DE LA CRUZ and GEORGE M. HUNT[1]

Director, Forest Products Research Institute, and FAO Advisor to the Philippine Forest Products Research Institute

G. M. HUNT

INDUSTRY-MINDED FORECASTERS of the Philippines have, for many years, realized the need for organized research on Philippine woods and forest products, and have urged the establishment of a laboratory devoted to this purpose.

Until recently, their desires could not be realized. Nevertheless, some forest products research was accomplished piecemeal over the years by the former Philippine Bureau of Science, the Bureau of Forestry, and the College of Forestry. These institutions were never adequately equipped or staffed for comprehensive forest products research, but, despite their limitations, they produced considerable information on various aspects of the subject and issued a number of valuable publications.[2]

The establishment of a forest products laboratory was officially recommended in the report of the "Economic Survey Mission to the Philippines", otherwise known as the "Bell Mission Report" dated Oct. 9, 1950. This recommendation began to bear fruit when, on January 1, 1954, the Forest Products Laboratory was established as a division of the Bureau of Forestry, and a chief was appointed to develop it into a functioning institution devoted entirely to research in forest products and able to undertake a comprehensive program.

The Laboratory was made possible by the joint efforts of the U. S. Government and the Philippine Government, as a part of the program of U. S. aid to the Philippines. Under this agreement, the Philippine Government provided substantial and adequate buildings, a research staff, and operating funds. The U. S. Government provided research and operating equipment.

The main building of the Forest Products Research Institute. Two other buildings complete the physical plant.

A third cooperator, the Food and Agriculture Organization of the United Nations (FAO), entered the project in April 1954, at the request of the Philippine Government, and provided a technical consultant to advise on problems of equipment, staffing, and research program. This consultant has remained with the project since that date. In addition, FAO has provided specialists in various fields who have served the project for shorter periods of time, to get individual phases of the research program started. To date, specialists have been provided in timber testing, pulp and paper, and veneer and plywood.

Since the cooperation between these three agencies began, a great deal has been accomplished. Buildings have been erected, equipment installed, more equipment ordered, a staff employed, specialized training given, and research started in several important fields.

In the beginning, the Forest Products Laboratory was a division of the Bureau of Forestry, and the Director of that Bureau was the Project Director. By an act of Congress in 1956, however, extensive reorganization of Philippine government functions was authorized, as a part of which the Forest Products Laboratory was ultimately divorced from the Bureau of Forestry and the Department of Agriculture and Natural Resources and made a semi-autonomous institution attached to the University of the Philippines. On July 5, 1957, the Executive Order putting this reorganization into effect was signed by the President of the Philippines. The Forest Products Laboratory and the Forest Products Research Section of the Bureau of Forestry were thereby merged and became the Forest Products Research Institute.

The Director of the Forest Products Research Institute is given considerable freedom to manage the personnel and business affairs of the Institute and to organize and carry out the research program, under policies laid down by a governing board of five members. The Board consists of the Director of Forestry (as Chairman) and the Dean of the College of For-

[1] George Hunt, a leader among the 14 original founders of the Forest Products Research Society, retired as Director of the U. S. Forest Products Laboratory in 1951. He has been in the Philippines as FAO Advisor to the FPRI since 1954.

[2] Brown, W. H. Minor products of Philippine forests, Vols. I and II, Bull. No. 22, Bureau of Forestry, Manila (1920–21).
Reyes, L. J. Philippine woods. Tech. Bull. No. 7, Dept. of Agr. and Commerce (1938).
Schneider, E. E. Commercial woods of the Philippines: their preparation and uses. Bull. No. 14, Bur. of Forestry (1916).

Microscope studies of wood structure and fiber dimensions provide basic information of wide application.

estry as ex-officio members, together with three members appointed by the President of the University of the Philippines. Of the three appointed members, one represents the lumber industry, one represents forest products industries other than lumber, and the third represents the general public. The functions of the Board are to establish policies and give general guidance to the Institute, leaving the details of daily operation to the Director of the Institute, who is given wide latitude for the exercise of his judgment within the established policies.

The Forest Products Research Institute is located in Mt. Makiling National Park near Los Banos, about 70 kilometers southeast of Manila. Its post office address is College, Laguna, Philippines. Although the Institute is about 1½ hours from Manila by automobile, bus, or train, and is thus not as conveniently reached as if it were located in Manila, the location has a number of advantages. It is in a locality that is rapidly becoming an important educational and research center of the Philippines. The Institute is immediately adjacent to the College of Agriculture, the Agricultural Experiment Station, the College of Forestry, and the principal Forest Experiment Station of the Bureau of Forestry. All of these are energetic, growing institutions whose educational and research influence is continually increasing. The beauty of the surroundings and the somewhat cooler climate of the Mt. Makiling area as compared to Manila are also favorable to research.

The campus of the Forest Products Research Institute now covers about five hectares. Its physical plant consists at present of three buildings, with a total floor space of over 5600 sq. meters, (about 60,000 sq. ft.).

The equipment of the Institute is already substantial, although still far from complete. The principal items of equipment that are already in use or on order are the following:

Four universal testing machines, the largest with 200,000 lb. maximum capacity and the smallest with a capacity of 8,800 lbs.

One impact testing machine with test hammers of 50, 100, 250 and 500 lbs. and supports for both impact bending and impact crushing tests.

One toughness testing machine.

Two rotary pulp digesters, capacity about 0.8 cu. ft. and 8 cu. ft., respectively.

Two Clayton steam generators and a steam boiler.

One large chipper with chip classification screens.

One 8-inch-diameter Bauer mill (pulp refiner).

One small Asplund defibrator.

One 3-ft. hydrapulper.

One 125-ton hot-plate press with plates 12 inches square.

Various pulp processing and testing equipment, freeness testers, pulp cleaners, pulp screen, fiber classifier, bleaching equipment, and many others.

Paper-testing equipment including mullen, folding endurance, tensile, thickness, tearing, weight, and other testers.

A Midget Fourdrinier paper machine that will produce a continuous sheet 8½ inches wide in a variety of weights.

Microscopes, microtomes, and other equipment for wood anatomy studies.

A well-equipped photographic laboratory.

A variety of equipment for chemical analysis and chemical studies.

A charcoal kiln and a charcoal briquetting plant.

A complete pilot-size, veneer and plywood manufacturing plant, including hot and cold log-storage tanks, a 56-inch veneer lathe, a 75-inch veneer clipper, a 78-inch knife grinder, a 40-ft. by 6-ft. variable-speed veneer dryer, a Bamford veneer slicer, glue mixer, 32-inch rubber-roll glue spreader, 26-in. by 26-in., 150-ton hot-plate plywood press, 50-in. by 50-in., 308-ton cold-plate press, a 4-plate compressometer press, a plywood shear-testing machine, and various smaller items.

A sawmill with 60-inch, inserted-tooth circular head saw and 40-inch top saw, edger, cut-off saw, band resaw, a heavy-duty combination planer and matcher, and minor equipment.

A wood-working shop with table saws, band saws, 18-inch single surface planer, jointer, wood-turning lathe, dowel machine, single-spindle shaper, borer, sanding machines, copying lathe, and other equipment.

A wood-preservation laboratory with two 2 by 3 by 20-ft. concrete open tanks, two 1½ by 4½-ft. pressure-treating cylinders, one equipped with "Rueping" cylinder and pressure-working tank, a heavy-duty general service air compressor and a vacuum pump, with preservative storage tanks and other accessory equipment.

One reversible-fan, cross-circulation dry kiln of about 2500 bd. ft. capacity and one of about 200 bd. ft. capacity, with needed accessories.

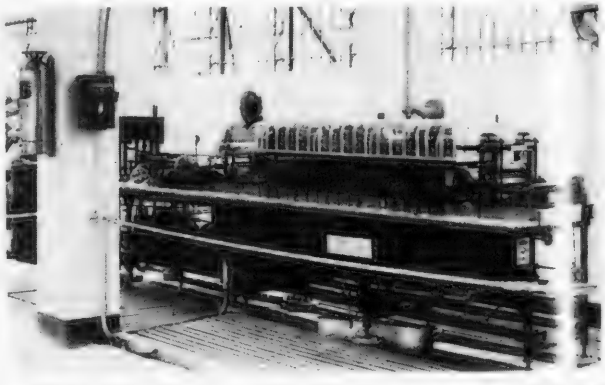
Four temperature-humidity controlled rooms, one kept at 73° F. and 50 per cent relative humidity for paper testing, one kept at 80° F. and 65 per cent R. H. for bringing timber test specimens to approximately 12 per cent moisture content for air-dry testing, one kept at high temperature and humidity to favor the growth of staining and decay fungi and the deterioration of glue joints, and a "cold room" kept at about 40° F. and high humidity for storage of green material, resin glues, and similar uses.

One temperature-humidity control cabinet for bringing shrinkage specimens to about 12 per cent moisture content and 5 per cent moisture content respectively, and one low-temperature control cabinet for studying the growth-temperature relations of fungi.

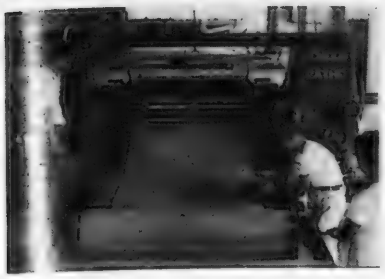
The Institute also has a good technical library specializing in the field of research and wood utilization.

The present authorized permanent staff of the Institute totals 162, of which nearly 100 have had profes-

Two revolving digesters for chemical pulping.



"Midget" Fourdinrinier paper machine. It can produce a continuous sheet of paper 8½ inches wide in a wide variety of weights, thicknesses, and qualities.



Veneer lathe for rotary-cutting veneer from bolts up to 56 inches long. The lathe can be set to cut thicknesses from 1/500 inch to 2/5 inch, in increments of 0.004 inch.

sional or technical training to the extent of at least graduation from college. The remainder have subprofessional, mechanical, electrical, and other skills. Since there is no large pool of personnel trained in research to draw upon, the Institute must depend mainly upon recent graduates from science and professional courses for most of its research workers. It began its work with a few leaders with forest products research experience, and these must carry much of the burden of training the junior staff on the job. Fortunately, it has been possible to send a considerable number of trainees abroad for specialized training in their respective fields with the assistance of various cooperating organizations.[3]

At present, the staff is organized into one administrative and four research divisions as follows:

The Administrative Services Division handles the business, personnel, library, publications, buildings and grounds, motor pool, labor pool, repair and maintenance, and related functions.

The Chemical Investigations Division conducts research in the chemical composition of wood, the manufacture of pulps of various kinds, paper and wallboards, the production, processing, and use of minor chemical forest products, including charcoal, resins, oils, extractives and the like, and other chemical investigations.

The Industrial Investigations Division is concerned with timber testing, structural uses of wood, and quality evaluation of wood for specific uses.

The Wood Preservation Division conducts research in physical properties and seasoning, the treatment of wood with preservatives, the durability of treated and untreated wood, and studies in pathology and entomology relating to the control of wood-inhabiting fungi and insects.

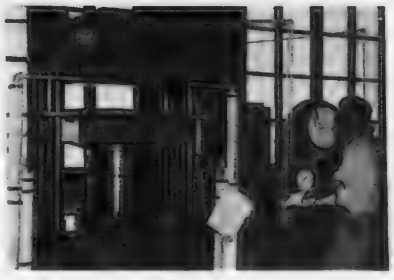
The Wood Technology Division studies wood structure and identification, develops the wood collection, herbarium and check lists of species, studies minor non-chemical products (including brush fibers), and conducts the research on veneer and plywood manufacture and wood gluing.

A more logical organization of the work with the addition of one or more new divisions will be possible after the second year of operation under the present organization.

The Institute faces an enormous research program because of the large number of forest tree species in the Philippines, the small amount of research that has been done upon them, the urgent need for basic information on the properties, characteristics, and processing of individual species, and the economic necessity to develop profitable industrial uses for wood residues and species that now go to waste for lack of market. There are said to be some 3000 tree species in the Philippines that grow to a foot or more in diameter. There are also many species of bamboo and other forest plants and products that have potential or actual commercial value. Probably not over 60 of the tree species are in extensive commercial use at the present time, and not over 200 enter into commerce at all.

The bulk of the early work of the Institute must be directed at the species now in commercial use or likely to be before long because of the quantities available or because of some characteristic or property for which a special market exists. Work on the remaining species will ordinarily be carried on only incidentally, as time can be spared from more urgent work or as special circumstances may require.

In the early years of the program, a large part of the effort must go into collecting information on basic properties and characteristics of species and classifying them into groups with regard to their properties or reactions to processing. Studies of this kind are now being pushed to collect, for the important species, accurate and adequate information on chemical composition, specific gravity, shrinkage properties, mechanical properties, fiber dimensions, seasoning characteristics,



Hot-plate gluing press with automatic temperature and time controls. The 26-inch-square plates have a maximum capacity of 150 tons, which is about 440 psi over the whole plate, or 880 over half the area.

preservative treatability, resistance to fungi and insects, and other properties.

Studies of a developmental character must also be included in the program, however, to meet immediate needs for such information. Projects of this kind include making a search for local forest fibers that can be used commercially for brush making, developing processing details that will make marketable papers from individual species of wood or bamboo, or their mixtures, searching for methods of improving the quality and value of veneer and plywood or of insuring their compliance with commercial grading rules and specifications, and many others. Basic and developmental studies are combined in some projects, as in searching for woods suitable for special uses such as artificial limbs, pencil slats, tool handles, tight cooperage, and other products with special characteristics. These investigations afford opportunities for early application of basic data on characteristics.

In common with all other forest products research institutions, the Philippine F. P. R. I. finds that the available funds are far too small to finance an adequate research program. Nevertheless, much can be accomplished with the money and staff available. The continuing obligation is to accomplish the maximum results possible with current assets while working towards a larger staff and better equipment in the future. The work done through the years by the other forest products research institutions of the world will necessarily be drawn upon continuously by the Philippine F. P. R. I. in planning its studies and meeting its obligations to the people of the Philippines. In its turn, the Forest Products Research Institute hopes to develop information that will be of interest to other countries and thus to take its place as an important contributor to the common pool of knowledge about the properties and efficient utilization of the products of the forest.

[3] The financial and other cooperation received by the Forest Products Laboratory and its successor, the Forest Products Research Institute, has been so widespread that it is impractical to name all who have given such assistance. The chief financial contribution for equipment and training of personnel abroad has come from the International Cooperation Administration, but a large contribution has been made by the Food and Agriculture Organization of the United Nations and substantial ones by the British and Australian governments under the Colombo Plan, the Rockefeller Foundation, the Forest Products Laboratories at Madison, Wisconsin, and Melbourne, Australia, the Philippine Mahogany Association, and a number of universities in the United States. Contributions to the library of the Institute have been made by many individuals and organizations in addition to those named above. A great part of the progress made by the Institute to date would have been impossible without the cooperation of these organizations and individuals.

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1948—Vol. II—UTILIZATION, FIBER PRODUCTS, BARKING, FINISHES, MACHINERY, R. F. HEATING. 50 papers, 500 pp.

Articles cover: economics of wood-waste utilization; losses in Redwood logging; small log gang sawmill; utilization of low-grade hardwood lumber; wood-distillation industry; sawdust carbonization; animal feeds from wood residue; small wood briquetting machine; special machines for utilization of waste slabs for glued core stock; interior trim from wood waste; wood-fiber production with revolving disk mills; effect of some manufacturing variables on the properties of fiberboard prepared from milled Douglas-Fir; small hydraulic log barker; mechanical methods of bark removal; studies on the chemical composition of bark and its utilization for structural boards; research in industry laboratories; history of furniture finishes; finishes resistant to alcohols and acids; low-bake synthetic finishes; simple testing methods for finishers; planning floor space for woodworking equipment; maintenance and operating practice for tungsten carbide tools. **Regular price $8.00 Now $2.50**

1949—Vol. III—RAW MATERIAL, FURNITURE, PLYWOOD, UTILIZATION, GLUES, SEASONING. 55 papers, 607 pp.

Articles cover: more wood per acre; integrated wood utilization at Crossett; harvesting sawlogs; portable wood chippers; wood fibers from veneer waste; small permanent-type sawmills in better forest utilization; pulpwood handling in the Lake States; tropical wood research for the furniture industry; effect of plywood glue lines on the accuracy of moisture-meter indications; No. 3 common Northern hardwood lumber for mechanized processing into glued products; cut stock from western softwoods; assembly material in furniture manufacture; supplementing wood with metal in furniture manufacturing; extending hot press urea resin with wheat and rye flour; furniture finishes; lumber core panels; rotary veneer cutting; molding plywood; insert-point circular headsaws; ills besetting the furniture industry; utilization of Redwood bark; utilization of waste sulfite liquor in concrete; semichemical pulping; dry-formed boards bonded with resins; wood, plywood and hardboard; compreg-resin-treated densified wood; wood preservatives; wood boring beetles; ignition temperatures of fireproofed wood, untreated sound wood, and untreated decayed wood; wood waste disposal and air pollution control in the Los Angeles area; pulp mill pollution; chemical composition of Ponderosa and Sugar Pine barks; lumber recovery from Douglas Fir logs in British Columbia; resin adhesives; development of working stresses for stress-grade lumber; design and performance of laminated wood trusses; glued laminated wood; glued laminated Wej-weld frames; radio frequency heating. **Regular price $8.00 Now $2.50**

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Articles cover: quality of second growth Douglas Fir; grading problems; quality control and the improved seasoning processes of the Redwood industry; saw teeth in action; lumber research to meet modern competition; hardwood log grading; recent developments in wirebound containers; method of utilizing and fabricating waste lumber; tests of strapped and lightweight lettuce crates; recent developments in containers; papermaking fibrous raw materials; utilization of low-grade hardwoods and softwoods; relation between wood and pulp properties; power vs. hand falling and bucking in logging operations; handling pulpwood; quality control in sawmill operations; hardwood plywood quality control; quality control in furniture production; defect detection equipment; non-destructive testing. **Regular price $8.00 Now $2.50**

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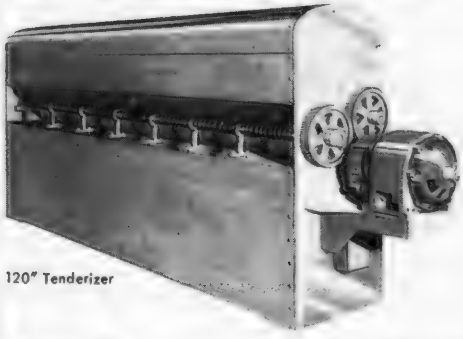

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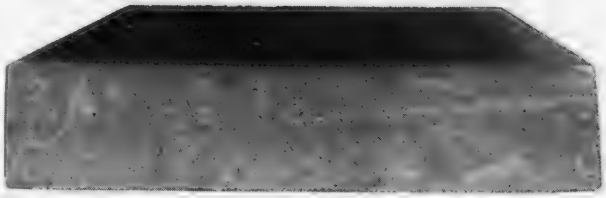

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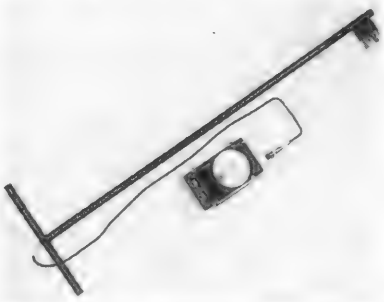

Electrode for Moisture Measurement

An accessory electrode that measures the moisture content of inside boards in air drying piles and kiln loads has been released by the Delmhorst Instrument Co. Designed for use with the firm's moisture detector, the electrode can be used for testing three feet from the edge of the pile if stickers of ¾ inch or more are used.

The "T–Handle Electrode" is slid between stickers into the lumber pile, and the T handle is turned, forcing electrode pins into the wood. Moisture content then registers on the meter. Turning the handle in the opposite direction removes the pins from the wood. Priced at $30.00 f.o.b., the electrode is produced by the Delmhorst Instrument Co., 619 Cedar St., Boonton, N. J.

TECO Pole Frame Design

A new design for low-cost pole-frame warehousing facilities for farm and commercial buildings has been prepared by Timber Engineering Co. The new pole-frame design uses simplified roof truss fabrication made of 2-inch framing lumber. The design is adaptable for spans from 30 to 40 feet, with a roof slope of 4 inches in 12 inches and truss spacing of 11 feet on centers.

Copies of the new pole-frame design, No. 679, are available on request to designers and builders from the Timber Engineering Co., 1319 18th St., N. W., Washington 6, D. C.

LeTourneau Log Stacker Booklet

An eight-page booklet on the "Series F" Electric Log Stacker has been released by R. G. LeTourneau, Inc. The three-color brochure presents general features of the log stacker plus information about the LeTourneau system of electric power and control. On-the-job photographs illustrate how the stacker works. The pamphlet is available free by writing for Bulletin No. 105 to R. G. LeTourneau, Inc., 2399 South MacArthur, Longview, Texas.

New Walnut Booklet

"An Architectural Study of Walnut for Commercial, Institutional, and Residential Interiors" is the title of a brochure recently announced by the American Walnut Manufacturers Assoc. The 16-page booklet suggests various ways of using walnut, and contains a source list intended as an aid in locating local sources of walnut plywood paneling and solid walnut paneling and trim. Available without charge from the American Walnut Mfgs. Assoc., 666 North Lake Shore Drive, Chicago 11, Illinois.

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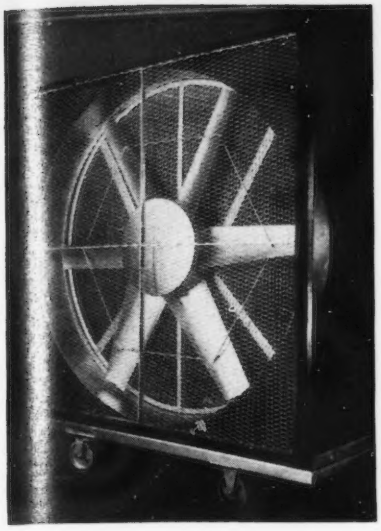

Air-Drying Lumber Fan

An outdoor fan for the open air drying of lumber, produced by Robert Hildebrand Co. of Canada, is now being sold by the Bell Machinery Co., Birmingham, Ala. The fan is said to help eliminate sap stain, rain and water accumulation, and reduce moisture content prior to entering the kiln at a considerable saving in time and power costs.

The fan has a frame eight feet high that can be mounted on wheels so it can be moved along parallel with the lengths of lumber stacks. The fan sucks the air through the stacks on one side of the fan, and blows it through the stacks on the other side. Intercellular moisture, it is reported, can be quickly reduced down to 25 per cent moisture content and lower, depending on the daily weather influence. More information can be obtained from the Bell Machinery Co., P. O. Box 490, Birmingham 1, Ala.

Two New Phenolic Resins

Two phenolic resins have been developed by Reichhold Chemicals Inc. to produce fast-curing wood-waste molding and true molding compounds with medium or short flow, the firm announced recently. It is reported that, when combined with wood flour and proper dyes, the two RCI resins produce general-purpose molding materials with good electrical, mechanical, and water resistant properties and fast curing cycles.

Single-Spindle Shaper

Yates–American Machine Co., Beloit, Wis., has announced the production of a new single-spindle shaper. New features of the machine are reported as a table area totaling 851 square inches, rugged spindle construction that permits use of a 1-inch spindle extension, and complete enclosure of all moving parts except at point of cut.

A choice of motors and controls is offered: for 3-phase wiring 1, 1½ or 2 hp can be installed; for single-phase wiring, either 1 or 1½ hp can be used. The machine, Model J–151 with infeed and outfeed fences, front extension, three table inserts, ½-inch and ¾-inch spindles, motor pulley, and belt, is priced at $299.00.

Accessories designed for the machine include holddown and holdover springs, miter gage, shaper hood, holddown ring for contour work, and reversing switch.

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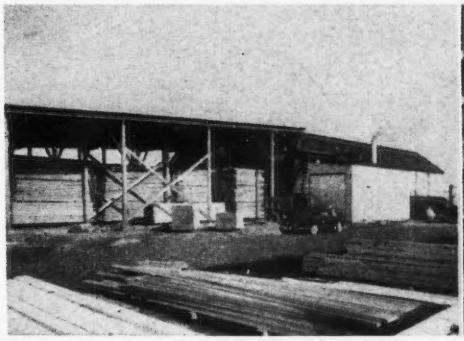
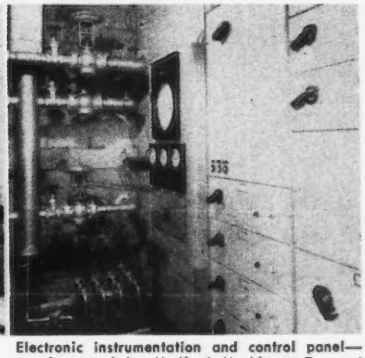


Exterior view of new Fryer Dry Kiln at Springfield Lumber Mills, Springfield, Oregon.



Electronic instrumentation and control panel—engineered by Medford Machinery Co. and Brown Div. of Minneapolis–Honeywell Co.

THE LUMBER DRYING PLANT at Springfield Lumber Mills is typical of the work being done by MEDFORD MACHINERY COMPANY throughout the West.

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Reciprocating-Blade Power Saw

A new power saw that uses a reciprocating blade instead of a chain is being produced by the Wright Power Saw Division of Thomas Industries Inc., Louisville, Ky. The saw is designed for the removal of limbs and for felling small trees.

The saw weighs 25 pounds, uses a 20-inch cutting blade operating at 10,000 strokes per minute, and has direct drive from piston to blade. More information is available from the manufacturer at 410 S. Third St., Louisville 2, Ky.

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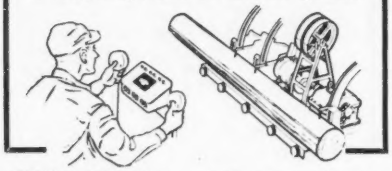

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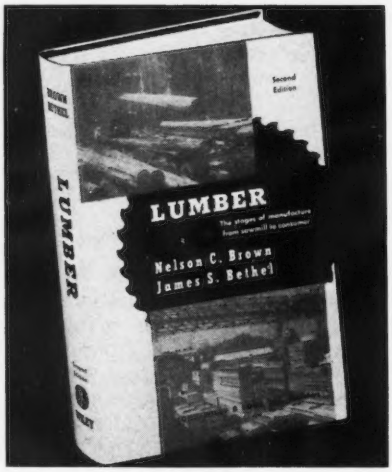

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- Log Storage and Handling
- Sawmill Machinery
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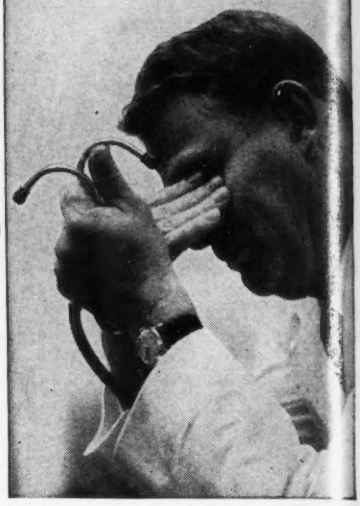
I watched a child die of cancer



SHE WAS too weak to speak . . . this child of eight. But the words were plain to see in her eyes: ***"Can't you make me well again, Doctor?"***

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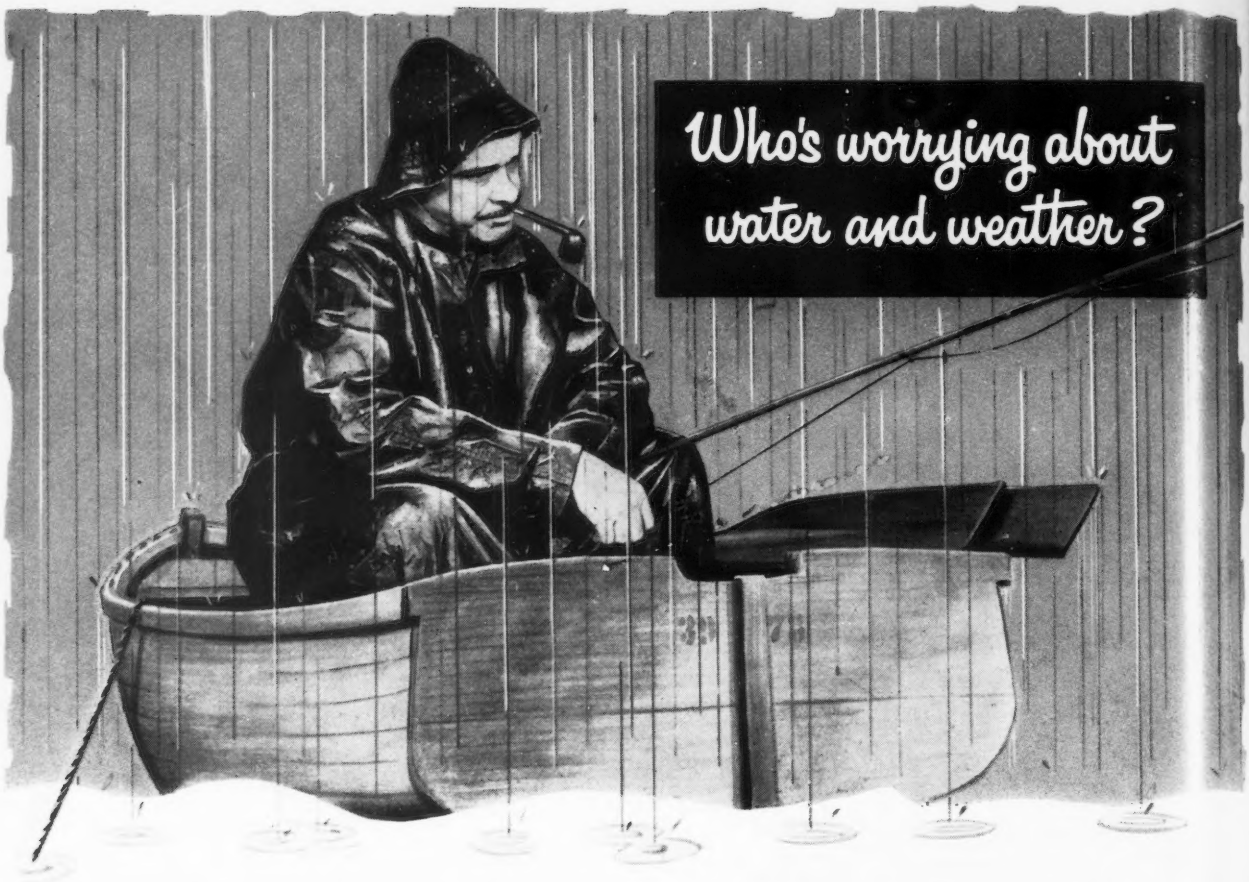

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